VOLUME 38
NUMBER 2

FEBRUARY, 1951

plating

HISTORY OF NICKEL PLATING IN U. S. A.

See Contents Page 139

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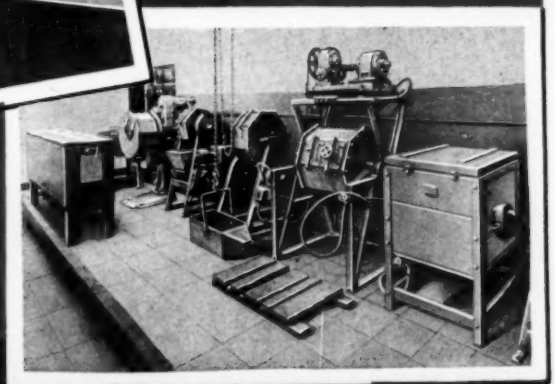

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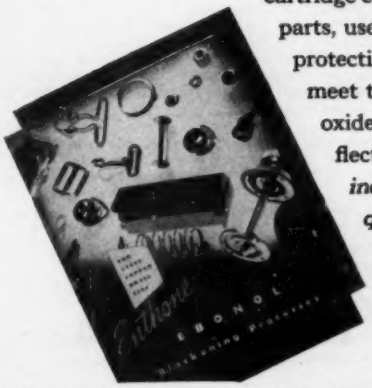

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New equipment and materials are combined to increase direct-labor savings over previous tumbling methods

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30% More Volume!

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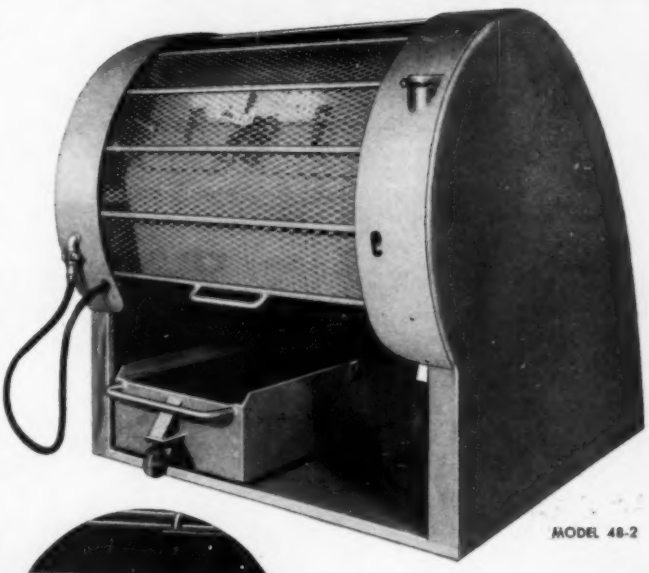
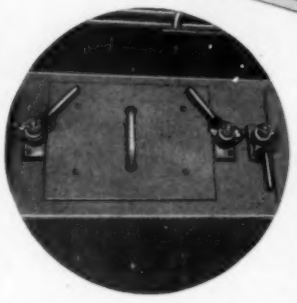
than comparable machines occupying the same square feet of floor space.

GRAV-I-FLO offers the first big advancement in modern tumbling—with improved equipment and materials for every tumbling need. New Grav-i-Flo process, with Super-Brite finishing chips and specially designed machinery giving a smoother surface and higher lustre, now cuts 25% to 40% faster on non-ferrous metals—eliminates subsequent operations such as ball burnishing. Grav-i-Flo compounds change chip surface from finishing to cutting in minutes—parts need not be transferred from cylinder. Grav-i-Flo de-burring chips are obtainable for all de-burring needs on both ferrous and non-ferrous metals.



MODEL 48-2



Cam locks on doors have manually released safety stops for pressure relief.

New Grav-i-Flo machines are available in three sizes: cylinder size 36" x 40" dia.; 48" x 40" dia.; and 66" x 40" dia. Compartments furnished ⅛" plate unlined or ¼" plate rubber lined. Cam lock doors have manual release safety stops. Reduced voltage control on magnetic starter. Lever or push-button switch. Limit switch on safety guard. 220-440 volt, 3 phase, 60 cycle motor with magnetic brake. Water attachment with hose. Counterbalanced safety guard. Hoist pan has tubular yoke with manually operated lock. All standard equipment. Variable speed drive and timer controls optional.

Motor Driven Separator—welded frame supports hoist pan. Separating screen, adjustable from 0° to 1½", accommodates various sizes and types of parts. Screen inclined 5° maximum. Pan shelf provided for stock pan. One HP 220-440 volt, 3 phase, 60 cycle motor with speed reducer, and manual starter with overload protection.

Samples Processed Free! Grav-i-Flo sample processing department will gladly tell you how to attain a better finish at lower costs. Send samples to distributors or direct to Grav-i-Flo Corporation.

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WOW!

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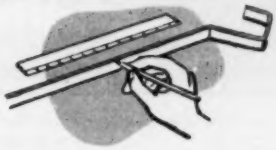
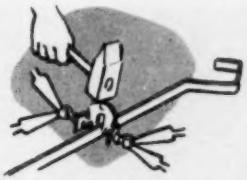


1 Measure and mark Spline



2 Drive-on STANDARD Saddle Tips *

*Patent applied for.

Eliminates expensive shop time used to bore and adjust splines

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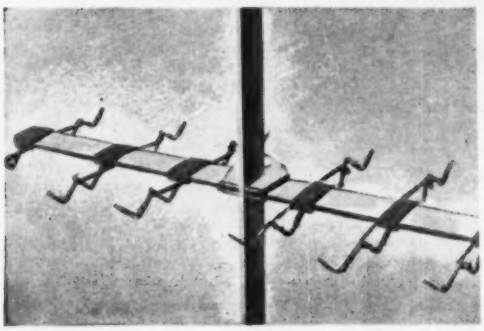

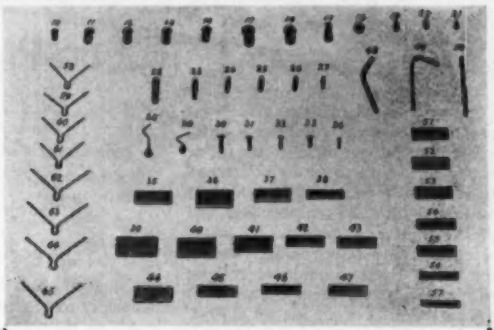

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Gentlemen: Yes, I am interested in STANDARD SADDLE TIPS. Please have your sales representative call, with a sample of this new—easy-to-use drive on Saddle Tip at no obligation to me.

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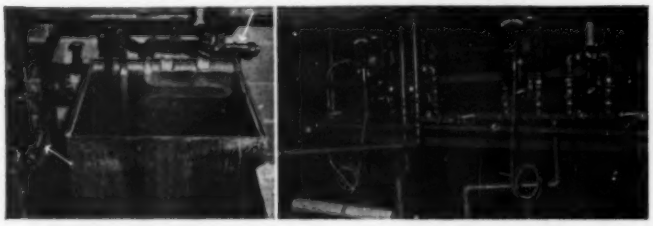

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You may not be able to make your present equipment completely automatic but you can make it automatic as far as temperatures are concerned at very small cost. That means that no matter how the temperatures and pressures of your steam and water supply vary, or how you are loading the tanks, the temperatures will be within a degree of the point at which you set the dials of the Sarco LSI Plating Control.

It also means that you can change the settings in a second for each tank and each load. This includes all kinds of plating, and alternate heating and cooling. It means that you can read the temperatures on the big dial, custom-cut, for easy reading in your temperature range.

For wash tanks a low cost Sarco Thermoton hooked into the line like an elbow will hold the tank within a few degrees. And for degreasers you can select the Sarco Vapor-line Controls, or the Sarco TR-40 Cooling Control. To save steam, Sarco Traps and Strainers are recommended for each tank or steam coil.

ASK FOR SARCO BULLETINS ON PLATING CONTROL

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Industry News

Honeywell Expands Brown Division Facilities. Minneapolis-Honeywell Regulator Company is expanding its industrial production and operating facilities in Philadelphia by purchase of the Thomas M. Royal plant and acquisition of about 60,000 sq ft of undeveloped property adjacent to its new site.

The Honeywell-Brown expansion in Philadelphia is the second in less than two years. When the company moved into its new building at Wayne Junction in May, 1949, it increased its over-all facilities from 231,000 to about 300,000 sq ft. The latest addition of 110,000 sq ft exclusive of undeveloped land, will almost double the area occupied in 1948.

School of Spray Painting. Starting the 26th year of its School of Spray Painting, the DeVilbiss Company announces the schedule of courses for the first half of 1951. Conforming with established policy, no charge is made for instruction. Enrollees pay only for meals and lodging while attending the school. Users of De Vilbiss equipment may make application now to enroll their spray operators and finishing-department supervisors for any of the one-week courses offered in the new school and research building at the main plant in Toledo.

The classes start February 5, March 5, April 2, May 7 and June 4. Applications should be made as far in advance as possible. Information is obtainable from the DeVilbiss Company, Toledo 1, Ohio.

The Chemical Institute of Canada will hold its 34th annual conference in Winnipeg on June 18 to 20. Papers will be presented in agricultural chemistry and food technology, analytical chemistry, biological chemistry and nutrition, chemical education, chemical engineering, organic chemistry, physical chemistry, and protective coatings. Outstanding scientists from Canada and the United States will address the conference, which is expected to attract chemists and chemical engineers from all parts of this country.

Standardization of Stainless-Steel Pipe and Fittings. Manufacturers of stainless-steel pipe and fittings met with representatives of the chemical industry on December 1 at the American Standards Association, New York City. They voted to request inclusion of Schedule 5S for light-weight stainless-steel pipe and fittings in an American Standard. The con-

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FULL LENGTH "CONDUCTA-CORE" INCREASES CONDUCTIVITY, RIGIDITY

Federated Conducta-Core Lead Anodes have a highly conductive and non-contaminating 3/8" diameter aluminum rod running from top to bottom. This, together with the unique design of the anode, assures complete rigidity . . . there is no curling, buckling or peeling to interfere with automatic plating operations.

The Conducta-Core makes every inch of the anode highly and uniformly conductive . . . more current can be carried than by ordinary anodes. Another advantage of the Conducta-Core Anode is the great number of high projections that give it greater-than-average throwing power.

No need to worry about anodes dropping into the tank because of corroded hooks . . . an improved lead coating 3/16" thick at the base of the copper hook is your guarantee of permanently attached anodes.

Federated Conducta-Core Anodes are available in all standard lengths up to 52 inches, and with a variety of hooks. Special sizes made to order. Flat Rolled and 3-Rib Lead Anodes can also be supplied.

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ference was held under the auspices of a subcommittee of the Chemical Industry Correlating Company of A. S. A.

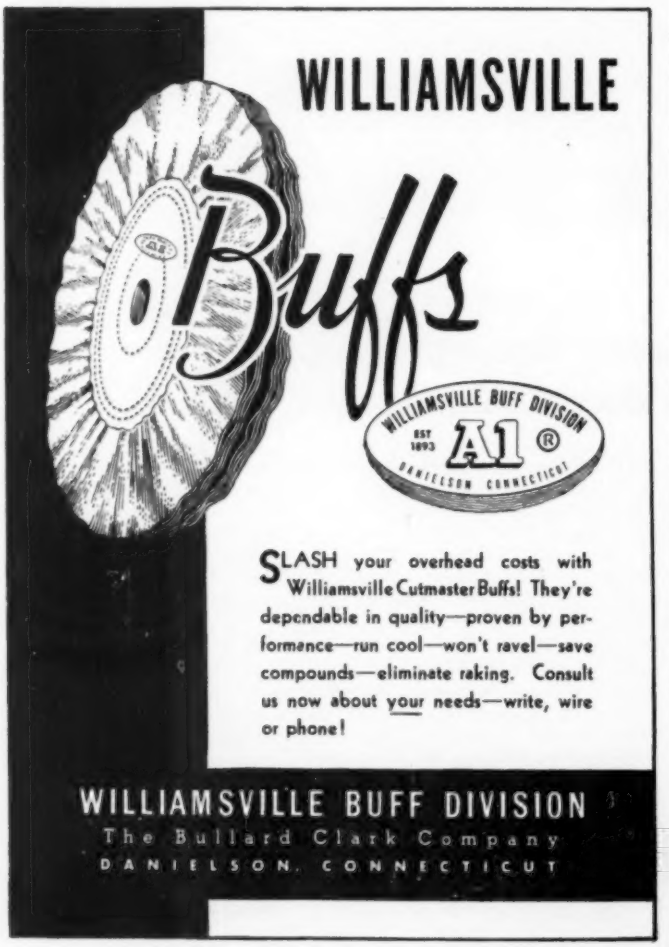
For the past two years the principal stainless steel tube mills have been manufacturing Schedule 5S stainless steel pipe on order from the chemical industry. The December 1 meeting was called to review the experiences of the companies using this schedule, which is as follows:

A nominal thickness of 0.065 inch for nominal pipe sizes of ½, ¾, 1, 1¼, 1½, and 2 inches, 0.083 inch for 2½, 3, 3½ and 4 inches, 0.109 inch for 5, 6, and 8 inches, 0.134 inch for 10 inches, and 0.165 for 12 inches.

Plating Supply Situation in New York City. According to its Monthly Bulletin, the Masters' Electroplating Association, 123 William St., New York 7, N. Y., held an open meeting on November 16 to discuss supply shortages. About sixty people were present, among them representatives of almost all major supply houses in the metropolitan district.

Those participating in the discussion included Messrs. M. N. Messing of Bart-Messing Corporation, R. Corey of Flurey Products Corporation, A. B. Hoefer of The Udylite Corporation, Dr. Fault of duPont, Donahue of Frederick Gumm Chemical Company, L. H. Cates of Enequist Chemical Company, Kraus of National Oil and Supply Company, J. E. Spencer of The Harshaw Chemical Company. All added information and made suggestions. Secretary Bregman suggested that the platers form and contribute to a hardship kitty.

Oakite Field Service Representatives from the Canadian, New England, New York, St. Louis, and Southern Divisions of Oakite Products, Inc., are shown gathered for annual conference held recently in Hotel Statler, New York City, to discuss technical-sales aspects of industrial cleaning and allied operations. Similar end-of-year conferences held in Cleveland, Ohio, and Hollywood, Calif., were attended by representatives from the Company's Chicago, Cleveland, Detroit, Milwaukee and Philadelphia Divisions and the Pacific Coast, Southwestern and Midwestern sales territories, respectively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Optimus Equipment Company, Matawan, N. J., has purchased the trademarks, patents, sales rights, etc., of the **Circo Products Corporation,** Cleveland, Ohio, manufacturers of metal-parts cleaning and degreasing machinery. The Circo manufacturing operations will be moved to Matawan immediately, where the manufacture and sale of Circo equipment and degreasers will be carried on through the Circo Division of Optimus. The present Circo distribution set-up will be continued and expanded. Optimus manufactures metal-parts washers, vapor degreasers, dryers, and pickling machinery for the industrial field and is a subsidiary of Hanson-Van Winkle-Munning Company.

Price of "Karbate" Pumps Reduced. Karbate Brand Impervious Graphite Pumps, manufactured by National Carbon Division, Union Carbide and Carbon Corporation, 30 E. 42nd St., New York 17, N. Y., has had their price reduced by as much as 33 per cent (not

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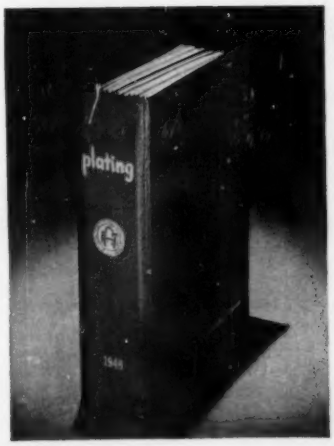

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Industry News

including motor). The new lower price, according to the manufacturer, permits universal application in addition to use in severe service. No longer is it necessary to specify a particular pump for sulfuric acid, another for hydrochloric and another for fluorides, chlorides, chlorinated hydrocarbons, etc. A pump purchased for a specific service can be used in almost any change in chemical operating conditions.

National Bureau of Standards Semicentennial. The year 1951 marks the fiftieth anniversary of the National Bureau of Standards. A large number of the principal scientific and technical organizations of the nation, in recognition thereof have planned meetings in Washington in 1951, among them the Electrochemical Society, April 8–12, and the Analytical Division of the American Chemical Society, June 14–16.

Created by Act of Congress on March 3, 1901, the Bureau is the principal agency of the Federal Government for fundamental research in physics, mathematics, chemistry, and engineering. The history of the Bureau actually extends back to the Constitution, which gave cognizance of weights and measures to the Federal Government. An Office of Weights and Measures grew out of various acts of Congress beginnin6 in 1830, and this Office was the immediate antecendent of the Bureau.

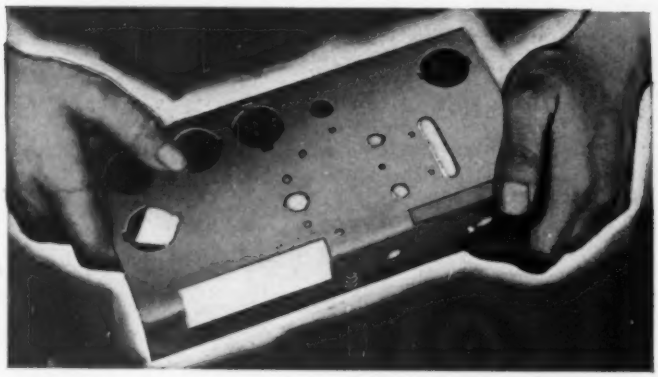
At the close of the last century, American industry and science recognized the need for a major national physical laboratory similar to those established in England and Germany. Problems relating to fundamental standards of science, physical constants, properties of materials, and methods and instruments of measurement called for a laboratory that would serve the entire nation. Industry, in particular, had need for fundamental standards of measurement and ready access to a source of calibration of industrial and laboratory working standards.

All working standards in research laboratories and industry are calibrated in terms of the national standards of physical measurement which the Bureau maintains. In addition, the Bureau carries on necessary research leading to improvements in such standards and in related measurement methods and instruments. New standards, methods, and instruments, in keeping with demands for greater precision and the opening up of new fields of science and industry, are also objects of research.

An equally significant aspect of the Bureau's work is that concerned with specific research and development projects in the physical sciences and mathematics. In addition to laboratory work, the Bureau, by virtue of its staff and facilities, is called upon to render scientific advisory services to the Government and industry. Its participation in the activities of scientific and engineering societies and bodies, both nationally and internationally, is necessarily extensive and varied.

The electroplating industry has had close contact with the Bureau since World War I, and for many years, beginning in 1927, the American Electroplaters' Society has maintained one or several research associates there. At present two of its research projects. No. 9 on "Physical Properties of Electrodeposited Metals" under Dr. Abner Brenner and No. 13 on "The Relation Between Permeability and Protective Value of Electroplated Coatings" under Fielding Ogburn, are located at the Bureau.

We join all others who are interested in science and technology in congratulations for work well done.



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When the plating shop treats them with WATER DIP #33

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IF YOU'RE DOING COPPER PLATING, you can cut out extra operations by using Water Dip #33. Work goes *directly* from the last hot water rinse into Water Dip #33—no need for rehandling and drying.

IF YOU'RE USING COPPER-PLATED PARTS, you will find that you can make excellent soldered connections, and you can make strong, uniform welds even after the parts have been dipped in Water Dip #33.

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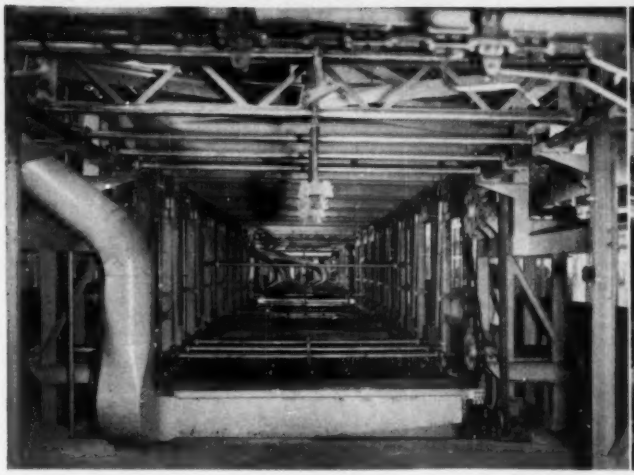
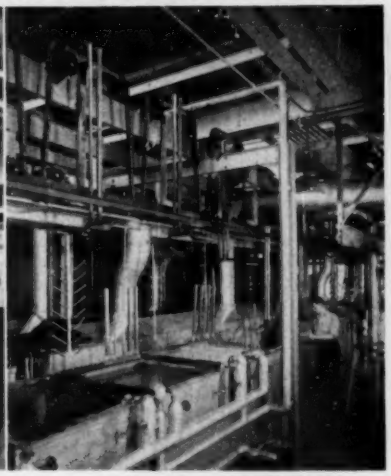
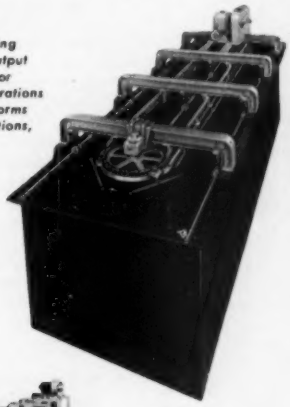


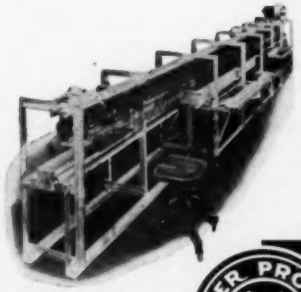
Typical Meaker Straight-A-Way Automatic Plating Machine. This type unit is designed to handle 125 racks or more per hour.



Meaker Return-Type Automatic Plating Machine for chromium-plating the large variety of parts in a high-quality line of plumbing hardware. Machine may be designed to copper plate, nickel plate and chromium plate in one continuous line.



A Meaker Semi-Automatic Plating Machine for use in medium-output plating departments and also for supplementing the plating operations in a Full Automatic which performs the cleaning, preplating operations, final rinsing and drying.



A special machine designed by Meaker for cleaning and silver plating small, brass contact clips.

You Get All Three with Meaker

Here's how! A Meaker plating machine makes every operation in the plating sequence automatic, or as mechanized as possible. This cuts to a minimum the manual handling of the parts in process—increasing production. The control of the quality of the plating is set and practically independent of the varying human element. A Meaker plating machine does clean up the plating room making for safer and more agreeable working conditions. And a bonus—in many cases the savings in the over-all plating costs have paid for the equipment in a short time.

Look to the handling methods in your plating department. You might be surprised what modern methods will accomplish. Whatever your requirements—full automatic, semi-automatic, or a special machine—Meaker has the answer.

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Personals

John T. M. Frey has been appointed Assistant Manager of the New York Branch and Lamar S. Hilton Assistant Sales Manager of the Abrasive Wheel Department of Raybestos-Manhattan, Inc., Manhattan Rubber Division, Passaic, N. J. Mr. Frey has been a member of Manhattan's New York sales organization for many years. Mr. Hilton formerly served as sales engineer.

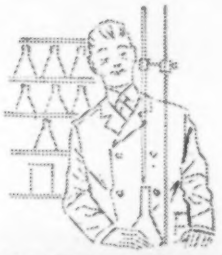
Samuel G. Baker, until now General Manager of the Electrochemicals Department, has replaced **James S. Denham** as General Manager of the duPont Company's Photo Products Department. Denham has retired after a long career in three of the company's industrial departments. The vacancy left by this transfer will be filled by **Donald O. Notman,** assistant general manager under Baker.

Baker, a native of Tacoma, Wash., began his company career in the Explosives Department, in 1923. He then took a B.Sc. degree at the University of Washington, and returned to duPont as a chemist at the Eastern Laboratory. Having held a number of other positions, Baker joined the Electrochemicals Department in 1943 as Director of the Electroplating Division. He was made assistant general manager of the department in 1945, and general manager on the retirement of Frank S. MacGregor on January 1, 1948.

Notman, born in St. Catharines, Ont., began his career in 1922 as a chemical engineer with the Roessler & Hasslacher Chemical Company, Niagara Falls, N. Y., following his graduation from Queens University, Kingston, Ont. He became an employee of du Pont when that company acquired R. & H.

From the developers of

IRIDITE®



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Bright plating troubles go down the drain when you specify ARP Brighteners for zinc or cadmium solutions in barrel, still or automatic equipment! Three trouble-free, efficient formulae, developed in Allied Research laboratories, are available to help you consistently produce a fine grained, clear and sparkling-bright plate:

1. For lowest cost operation of zinc plating without subsequent bright dipping or passivation! Increases solution efficiency to as high as 98% in low current densities. Produces a clear bright plate with a blue chrome-type cast.

2. For zinc plating followed by bright dipping or chromate passivation with Iridite! Lowest cost at high current densities. Yields a plate with a yellow nickel-type cast.

3. For cadmium plating. Produces a silvery bright deposit at any current density.

All three ARP Brighteners offer you many operating advantages including: better throwing power, increased solution efficiency, more efficient metal consumption, uniform coverage, reduced rejects, lower operating costs, higher quality work, ease of use.

INVESTIGATE TODAY! Ask your Iridite representative for full information or write direct. Mention type of plate desired and equipment used in your shop.

Manufacturers of Iridite finishes for corrosion resistance and paint systems on non-ferrous metals: ARP plating chemicals

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4004-06 E. MONUMENT STREET • BALTIMORE 5, MD.

W. E. Noyes, General Sales Manager of The Diversey Corporation, Chicago, for the last four years, has been named Vice-President in charge of sales. Upon graduation from Purdue University, where he majored in dairy manufacturing, Noyes was active in several important positions in the dairy industry and had been a staff member of the Lansing, Mich., Health Department for six years.

Noyes

With Diversey, in 1935, Noyes began as a field service representative in the Farm Quality Control Department, advancing to Manager two years later. In 1939, he was named Manager of the Cleveland Division, a position he held until 1943, when he was appointed Promotional Manager of the Dairy Department. He was made Assistant General Sales Manager early in 1946 and promoted to General Sales Manager in the Fall of that year.

J. O. Husting has joined the Sales and Technical Staff of O'Donohue Sales Company, Milwaukee, Wis. A graduate of Marquette University School of Chemical Engineering he was Plant Engineer of the Ogden Utah Plant of Solar Corporation.

Russell B. Weil has joined Franklin Metals Company, Newark, N. J., as buyer and seller of aluminum, brass, copper, zinc and other nonferrous scrap. He was formerly Assistant Purchasing Agent of Nassau Smelting & Refining Company, Tottenville, S. I., N. Y.

R. J. Gorecki is now Factory Manager of the Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J., succeeding **H. V. Snyder,** deceased. **W. E. Perkins** is Assistant Factory Manager.

Gorecki, who started in 1926 in the engineering department, has successively been in charge of mechanical development, the friction-material and cord-belt departments, standards, job evaluation, and production control, and became Assistant Factory Manager in 1946. W. E. Perkins joined in 1926 as a Laboratory Engineer. He later became Plant Engineer, Head of standards department, Superintendent of the compressed brake-lining and belt departments, and Manager of the cord-belt department.

Emil F. Frey, now in his 34th year with the sales organization of DeVilbiss Com-

The NEW 60 Series MURRAY-WAY HEAD!

ECONOMICAL ▸
VERSATILE ▸
COMPACT ▸

Here is a head, so compact it can operate on 30" centers—extremely versatile in use and positioning. It will save you many valuable feet of floor space and thousands of dollars in expenditure on smaller table diameters and costly conveyors and fixtures.

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This new head will be available in two models. The #61 rated at 10 to 15 H. P. and the #62 rated at 5 to 7½ H. P. Both carry the outstanding engineering features which have made Murray-Way equipment the finest in the field.

Write for our catalog of automatic polishing•buffing•grinding equipment.

3 Year Spindle Guarantee!

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is specifically manufactured to insulate your plating operations from grounds and short circuits through the heating coils, cooling coils, air agitation systems or other pipe connections. The True Insulator provides more positive insulation than any other type known.

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Manufacturers of Welded Fabrications to Specification

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Personals

pany, Toledo, Ohio, has been advanced from Assistant Sales Manager to Director of Sales Promotion and Advertising. Former Assistant Sales Manager **Henry M. Kidd** has become Sales Manager of spray equipment sales, after 16 years in various positions in the sales division.

Arthur L. Perkins is now Sales Manager of The Roberts Rouge Company, Stratford, Conn. He was formerly associated

Perkins

with the Minnesota Mining & Manufacturing Company and with Hammond Machinery Builders, and enjoys a wide acquaintance in the finishing industry.

C. Carlisle Tippit, Manager of the Order and Planning Department of The Reliance Electric & Engineering Company since January, 1948, has been appointed General Purchasing Agent of the firm. **Walter H. Behnke,** in Reliance's Applied Engineering Department since 1945, will take over Tippit's former duties.

Following his graduation from Williams College with a B.A. degree, Tippit, a Clevelander by birth, served two years overseas during World War II. He joined Reliance in 1945. Also a native of Cleveland, Behnke graduated from Fenn College in 1937 with a B.S. in Electrical Engineering.

Chet Borlet has joined the sales and service staff of United Chromium, Inc. He received his higher education at Kent

Borlet

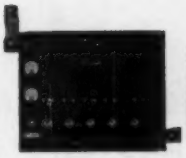
State University and has been well known for the past fifteen years as a member of the Plating Sales Department of The Harshaw Chemical Company, for the last eight years in Detroit. Here he has been active in the local branch of the American Electroplaters' Society and recently was elected to its Board of Managers.

Upon completion of orientation courses

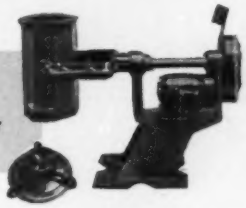
CROWN Equipment

Model 815 Selenium Rectifier

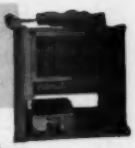
Crown Rheostat with Cut Out Switch



Crown Rheostat



Ball Burnisher

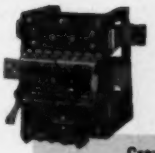


Crown Tumble Finishing Machines

Centrifugal Drier

Partially Automatic

Fully Automatic Plating Machines



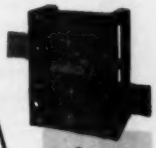
Crown Reversing Switch

Bench Type Utility Plater

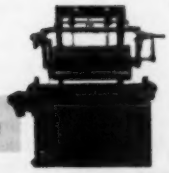
Bottle Type Tumble Finishing Machine

Tilting Type Tumbler

Rinsing and Drying Unit



Crown Disconnect Switch



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Process is foolproof and chemical solution can be applied by dipping, spraying, brushing or flow-coating.

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Alodizing is a chemical conversion process.

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Low chemical cost, short coating time and low temperature keep overhead down.

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The tough, durable Alodized surface makes paint stick to aluminum and resists corrosion. "Alodine" meets these Service specifications: MIL-C-5541; MIL-S-5002; AN-E-19; AN-F-20.

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Brush "Alodine" is easily and quickly applied to assembled aircraft in the field, shop, or hangar. Cleaning and coating chemicals for Brush Alodizing are shipped in bulk or in the convenient Brush "Alodine" Chemical Kit No. 1. This Kit contains enough chemicals to treat about 1000 square feet of surface and is an ideal package for use at airfields of commercial airlines or of the Armed Services anywhere.

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Personals

at the United Chromium organic-coatings laboratories and plating laboratories in Carteret and Detroit, Mr. Borlet will report to the Los Angeles regional office.

Frank G. Drake is now General Sales Manager of Bede Products, Inc., Cleveland, Ohio, succeeding **Richard E. Estabrook,** who has been advanced to General Manager. Formerly Eastern District Sales Manager, Drake has had over 35 years of experience in the synthetic and lacquer finishing field.

Edward S. Hawkins, Chemical Engineer with Rinshed-Mason Company, Detroit, Mich., has become General Manager of his company's recently acquired Western Division factory and warehouse at Anaheim, Calif.

Since graduating from West Virginia University in 1935, Mr. Hawkins has been continually active in paint research.

Obituaries

✚**Harry V. Snyder,** Factory Manager of Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J., died suddenly on December 2 at Point Pleasant Hospital, Point Pleasant, N. J.

Mr. Snyder, who was 56, left high school in 1909 to join Manhattan, starting in the billing department and continuing his education evenings. As the company expanded, he became successively head of other departments, including the statistical and estimating department, after which he was made Manager of the tubing and sundries departments. For over 25 years he was Manager of Manhattan's roll-covering and tank-lining departments. He became Assistant Factory Manager in 1942 and Factory Manager on September 8, 1944.

✚**J. F. Roche,** Chairman of the Board of the Binks Mfg. Co., Chicago, Ill., died on October 15, 1950, at 76.

His business life began in 1900 when he joined the Montana Power Co. In 20 years he worked his way up to Manager of the Butte District. Later Roche went to Hotpoint Division of General Electric Co. in Chicago as Assistant to the President and to the Apex Electric Distributing Co. as Vice-President. Here, in 1929, he accepted the position of Executive Vice-President and Director of the Binks Mfg. Co. Having successfully piloted his Company through the depression years Roche was elected President in 1936. Under his guidance Binks products improved and were standardized, and the manufacturing facilities were modernized and expanded. In April, 1949, Roche accepted the Chairmanship of the Board of Directors. His son, Burke B. Roche, became President, to carry on the work begun by his father.

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Have you taken advantage of AHCO's free engineering and analytical services? Let our trained representatives help you set up that new finishing room; let our chemists analyze the finishing chemicals you are now using . . . there is no obligation.

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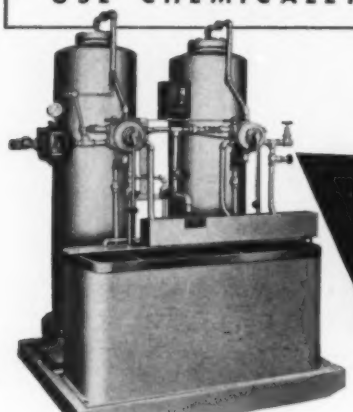

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And it's simple to get the complete facts for your case. Send us a water analysis and let us know how much water you have to treat and the gallons per hour needed. We can then give you the whole demineralizer story including estimated costs, equipment required, performance data, etc. for your requirements.

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Trade Literature

L—552. Fire Extinguisher—American-La France-Foamite Corporation, Elmira, N. Y., has published a 4-page illustrated bulletin describing a lightweight pressurized Fire-Gun of 1 quart capacity designed for one-hand operation on Class B and C fires. Aimed like a gun, it discharges the fluid, under 150-psi pressure, from a distance up to 25–30 feet. After recharging with fluid, air pressure is supplied from any standard air chuck such as commonly used at gasoline service stations. For your copy, use Reader Service Card.

L—553. Clean Water—Methods and equipment for industrial water filtration are illustrated and compared in detail in a 20-page Bulletin 691, prepared by R. P. Adams Company, Inc., 220 E. Park Drive, Buffalo 7, N. Y.

Pressure-filtration systems are graphically diagrammed in three colors to show application to virtually every industrial use. The text discusses origins of filtration practice and the development of today's filter media and backwashing techniques, including continuous automatic backwashing. The featured filtration equipment employs Adams Poro-Screen, Poro-Stone or Poro-Carbon filter elements covering the entire range of porosity from 0.0001 to 0.004 inch. Cut-away views, operating data, and piping suggestions for single and battery installations are provided for the information of design, process and operation personnel. For your copy, use Reader Service Card.

L—554. Table Model Electron Microscope—The new RCA Electron Microscope, Type EMT, is described in detail in a colorful brochure which has just been released by Dept. 521, Engineering Products Department, Radio Corporation of America, Camden, N. J.

Profusely illustrated, the 12-page booklet shows how this instrument contributes to industrial fields, as well as to college, school, and hospital laboratories. It contains full particulars on features, operation, and performance specifications. Diagrams and photographs explain the principles of electron optics and electron microscopy. For your copy, use Reader Service Card.

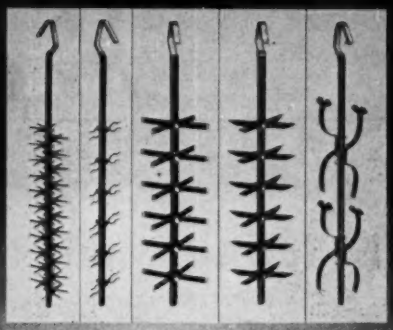
L—555. Regulators—A 32-page booklet containing useful information about pilot-operated pressure and temperature regulators is offered by Spence Engineering Co., Inc., Walden, N. Y. Fully illustrated, it discusses main valves, controls and strainers; gives capacities and flow data as well as dimensions and weights. Case problems are cited to help users se-

Time Savers For Platers

BELKE Electric Carboy Acid Pump — Transfers acids from carboys quickly and safely. Acid touches only the replaceable tube. Write for Bulletin 718R.

BELKE Current Density Meter—Hangs on cathode rod. Instrument dial shows amperes per square foot at plating surface. Write for Bulletin 439.

BELKE Permanent Tank Magnet—Recovers iron and steel pieces from bottom of plating tanks and barrels with minimum effort. Write for Bulletin 198R.

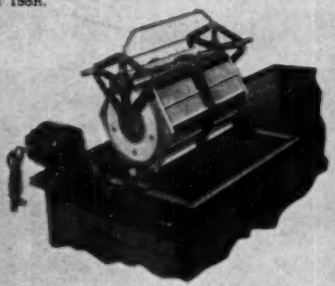


BELKE Utility Racks—*Enable you to plate new jobs without delay.* Five rack assortment efficiently handles 90% of all Plating Jobs, including bright nickel and chrome.

Removable tips and spines coated independently with BELKE Universal Plastic to withstand all cleaning and plating cycles. Spring pressure tips for copper-nickel-chrome service. BELKE Vac-Seal removable tips join rack spines with seep-proof seal and are easily interchanged or replaced. All five models in stock for immediate shipment, assembled or unassembled. Write for Bulletin 980.

BELKE Rubberite Tank Lining — Unaffected by acids and caustics at room temperature. Easy to apply. Write for Bulletin 951.

BELKE Rod Agitators for Plating Tanks—A necessity for good bright nickel plating. Recommended for plating die castings. Produces more uniform deposits. Write for Bulletin 199.



BELKE Small Lot Plating Barrels —For use with your present still plating tanks. Plates small lots efficiently and at low cost. Available in two sizes. Write for Bulletin 239JP.

BELKE Scrap Anode Baskets — Coated with Belke Universal Plastic to withstand all plating solutions. Write for Bulletin 10-BG.

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1. NEW LOW MATERIAL COSTS!

Each gallon of working solution you mix costs from as little as 35¢ down to only 8¼¢, depending upon solution concentration and appearance desired. In addition, you get an extra 10% discount on material orders for 2000 pounds or more!

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Iridite #8P is shipped to you as a *dry powder* in disposable steel pails. No liquids! No carboys! Saves up to 75% in freight; travels via low Third Class Rates. Pails take less storage space, reduce handling time and costs.

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A sparkling blue-bright finish results when you use Iridite #8P followed by a simple caustic soda bleach. Or, the coating can be produced as a golden-yellow iridescent film from a single dip by simply decreasing the concentration.

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New Iridite #8P can be applied by a simple chemical dip to any zinc or cadmium surface . . . plated, diecast, galvanized or sheet. Mixing is easy since the powder dissolves readily into solution. No special equipment or specially trained personnel is needed. Corrosion resistance is determined by the appearance desired; the choice is up to you. But for any appearance you are assured of maximum Iridite quality in corrosion resistant and paint base characteristics.

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Trade Literature

lect correct type and size for their particular applications. For your copy, use Reader Service Card.

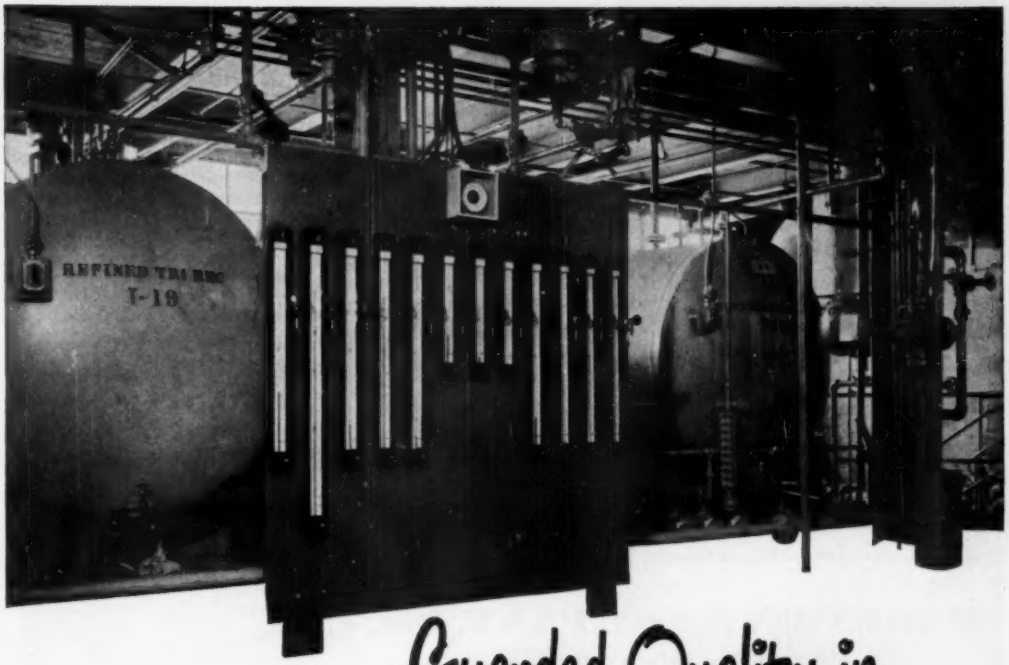
L—556. Acid, Alkali, Solvent Resistant Coating—The practical application of thick protective coatings of Carbo-Kote 6020 for tank and duct linings and for protection of equipment and floors is covered in Data Sheet C-42, issued by the Carboline Co., 7603 Forsyth Blvd., St. Louis 5, Mo. Having a solids content of 100 per cent and being fluid and free-flowing during application the material can be applied in 12 mil thick coatings in one application even on verticle surfaces. The coating is said to harden at room temperature to a very hard protective film resistant to all acids except oxidizing types and to practically all solvents and alkalis. Whereas abrasion resistance is excellent, there is sufficient flexib'lity for steel-tank-lining service without fiber reinforcement. The material is nontoxic and noncontaminating.

The data sheet covers the process of application to steel and concrete, for which primer coats are required, and to wood, glass, carbon, porcelain, rubber and stoneware, for which no primer is required. Coverage, drying and working times, corrosion resistance, uses and prices are also given. For your copy, use Reader Service Card.

L—557. Solvent-Emulsion Cleaners—A folder which describes a series of emulsion cleaners which have been designed to remove both oil-soluble and water-soluble soils from any metal or alloy, without attacking the base metal, and harmless to most paint finishes, has just been issued by the Detrex Corporation, Box 501, Detroit 32, Mich. For your copy, use Reader Service Card.

L—558. Cut-Off Wheels—An attractive 6-page Bulletin No. 6888 C listing wheel-grade recommendations and cutting-performance data as well as operating suggestions for the Delta Cut-Off Machine has been issued by the Abrasive Wheel Department of Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J. For your copy, use Reader Service Card.

L—559. Porosity Test—An illustrated 4-page Bulletin 500, issued by Dy-Chek Company, Division of Northrop Aircraft, Inc., 1515 E. Broadway, Hawthorne, Calif., fully describes Dy-Chek, the dye-penetrant method of metal inspection, and shows how this chemical process simplifies nondestructive testing. Dip, brush, and spray methods are explained, and varied applications in factories and in the field are discussed. For your copy, use Reader Service Card.



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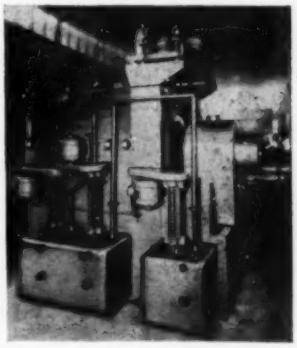
Equipment and Supplies

E—621. Automatic Treatment of Small Parts—N. Ransohoff, Inc., 16 E. 72nd St., Cincinnati16, Ohio, has brought out the Ransomatic to perform, in sequence, preplating operations on small parts without any manual labor. It is equipped with a standard Ransohoff Batch Process drum of the proper size to handle usual-size batches. The drum is either acid-resistant stainless steel or rubber lined, depending on the nature of the



work and whether sulfuric acid or muriatic acid is used in the pickling operation. The machine is equipped with as many tanks and pumps as there are solutions and with large automatic drain valves to drain the solution from the drum into the proper tank. The whole cycle is controlled automatically through a time switch.

The work is charged into the drum with the drum rotating in the tumbling direction. Following the required treatments the rotation is automatically reversed, discharging the work. The constant agitation reduces the time considerably from that required on dipping of baskets. The unit has also been used for descaling and neutralizing small forgings and similar work. For further information, use Reader Service Card.

E—622. New Sealer—A material which remains liquid as long as a stream of air bubbles through it but hardens in a few minutes when away from air, has been developed in the chemistry division of the General Electric Research Laboratory. Called "anaerobic permafil", its properties are thus opposite to those of paint, which hardens when exposed to air. This new material is able to penetrate extremely small cracks before hardening. Thus, a possible application is a tight seal for stopping nearly invisible leaks, or a "pipe dope" for sealing threaded unions.

When two metal strips are coated lightly with it and clamped together the

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 103.

How to Determine Impurities in Electroplating Solutions

Of all methods for determining minute impurities in plating baths, the most practical is the *colorimetric*. The principle utilized is simple: color intensity, due to presence of a colored constituent, is directly proportional to the concentration of that constituent.

USE OF THE COLORIMETRIC METHOD

This method requires the measuring of light transmitted by solutions.

Intensity of the transmitted light is measured by photoelectric means to attain a high degree of accuracy. No two solutions of different character will have transmittancy curves of exactly the same shape, hence, a solution under test is usually compared to a reference solution free of impurities. Calibration curves plotted from a series of runs facilitate determinations. Summaries of techniques used to determine four different impurities follow:

LEAD IN NICKEL PLATING BATHS

Lead is separated from interfering ions by extraction with a carbon tetrachloride solution of dithizone in the presence of potassium cyanide. After removal of the excess dithizone with alkaline potassium cyanide, the transmittancy of the solution is measured and the quantity of lead present determined from a calibration curve.

IRON IN NICKEL PLATING BATHS

Iron is separated from the other metallic ions by precipitation with cupferron. The iron cupferride is extracted with amyl acetate and then returned to the aqueous solution by shaking the amyl acetate extract with nitric acid. The iron is then reduced with hydroxylamine hydrochloride. O-phenanthroline is added, and the pH is adjusted with sodium acetate. Finally, the light transmission of the ferrous o-phenanthroline complex is measured.

MANGANESE IN NICKEL PLATING BATHS

The manganese is oxidized to permanganate by sodium periodate in an acid mixture of phosphoric and perchloric acids. The transmission of the solution is then measured.

COPPER IN NICKEL PLATING BATHS

Copper is isolated from the other constituents in the plating bath by precipitation with 2-mercaptobenzothiazole and extraction of the precipitate with amyl acetate. The color is then developed by addition of dibutyl amine and carbon disulfide. After the solution has been diluted with ethyl alcohol, its transmittancy is measured.

A.E.S. RESEARCH PROGRAM

The American Electroplaters' Society is conducting a comprehensive research program and has developed useful information on current plating problems. International Nickel, in addition to its other support of this program, feels that it will be a further service to make copies of these A.E.S. Research Reports available.

For an authoritative, detailed, 48-page study of this subject, we offer you a free copy of the A.E.S. Research Report, Serial No. 3, entitled *"Determination of Impurities in Electroplating Solutions."* Write us for your copy, now.

• • •

Because of unusually heavy industrial and defense demand, rationing of nickel has been in force since July 1st. On January 1, 1951, National Production Authority Order M-14, respecting the consumption of primary nickel, went into effect.

We shall continue to issue information on new developments and user experience with nickel-containing materials as we believe that dissemination of such data can help to promote the intelligent utilization of critical materials, so essential in these times.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

Equipment and Supplies

joint will support ten pounds after ten minutes. After 20 hours, it will hold 100 pounds. If still faster hardening is desired, the permafil may be heated, up to 212° F, and solidification takes place in a minute or less.

Certain metals, such as copper, iron, and silver solder, exert an accelerating action on the hardening process, even at room temperature. Anaerobic permafil is still the subject of experimental investigation, and thus far only limited laboratory quantities have been produced. It is not yet available commercially.

E—623. Laboratory Rectifier—Kocour Co., 4800 St. Louis Ave., Chicago 32, Ill., offers a 0-6/12 volt, 5 amp continuous-output selenium rectifier with smooth rheostat control of current. Choke input (115 volt, 60 cycle) filter gives less than 5 per cent ripple. For further details about this current source for Hult-cell and Haring-cell tests and small-scale plating, use Reader Service Card.

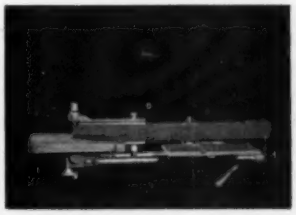
E—624. Aluminum Bright Dip—Development of a new and inexpensive process for brightening aluminum and its alloys is announced by Kaiser Aluminum & Chemical Corporation, Palmolive Bldg., Chicago, Ill. The process, on which patents are pending, will be made available under license to aluminum fabricators and processors.

Kaiser Bright Dip uses a low-acid-concentration bath and a simple work-flow pattern. The bath is said to be easily maintained by inexpensive, periodic additions of the active components to give it unusually long life, as much as 90 square feet of surface having been processed per gallon of solution with only slight additions.

Laboratory tests show that the dip enhances the appearance of all aluminum alloys, and is particularly effective on high-purity aluminum, such alloys as 2S, 3S, 52S, 61S and 150S and on the clad forms of 24S and 75S.

Products for indoor applications may be dyed following bright-dipping and anodizing, or left in natural color. Such applications may include ice cube trays, electrical appliances, water tumblers, kitchen and sewing racks, interior decoration, or anywhere a bright surface is desired. Bright-dipped products can also be used in outdoor applications. For further information, use Reader Service Card.

E—625. Precision Belt Grinder—George F. Grant Co., Inc., 44 Kempton Place, West Newton, Mass., announces the new Grant Contour Grinder, employed as an accessory to any drill press by simple mounting on the drill press column.



Using standard 2½ x 60-inch belts, the grinder furnishes a single device for complex grinding of concave and convex parts and radii, for deburring, for shaping, and other uses. Change of belt ratio or spindle provides speed ranges from 7,000 to 36,000 rpm. A special interchangeable spindle attachment provides continuous roll form or cylindrical grinding. Feltwheel blanks may be shaped to meet varying requirements. Table may be moved to rear of driving pulley for exceptional'y large grinding operations. Special equipment includes a spindle-grinding attachment using 3/8–2 inch diameter abrasive sleeves for internal surfaces. For further information, use Reader Service Card.

E—626. Air Line Filter—In a new air-line filter, manufactured by A. Schrader's Son, Div., 473 Vanderbilt Ave., Brooklyn 17, N. Y., the filtering element is composed of hundreds of fine laminations. The filtering area is thus said to be large enough to assure full air flow even after long periods of use. Moisture that is trapped can be removed through a drain cock. The filter is available in three standard pipe sizes: ¼, ⅜ and ½ inch. Pipe connections are the straight in-line types. When placed in the air line ahead of any air-control mechanism or air-operated tools, it protects them by removing

Buffed Zinc Base
DIE CASTINGS
Cleaned BEST with
PERMAG 340
Soap Pre-soak Hot Tank Pre-cleaning

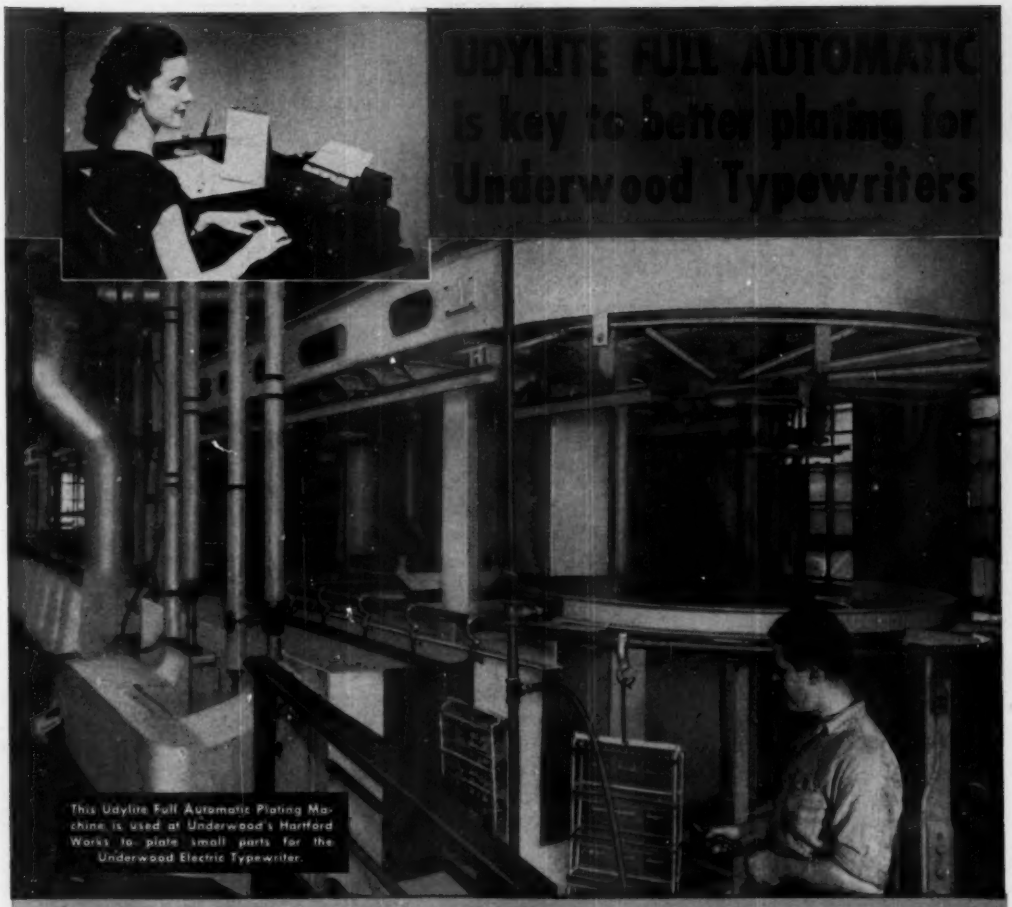
Complete and thorough tests on Buffed Zinc Base Die Castings prove the efficiency and economy of this new and powerful cleaning compound.

The test on zinc base die castings, shows elimination of all film, greater rinsability, freedom from discoloration and faster cleaning action.

Where pre-cleaning of zinc die castings failed with alkali or solvents which were inflammable, odorous and unstable, PERMAG 340 now does this cleaning job with perfect satisfaction.

If you have buffed zinc base die castings hard to clean, PERMAG is your answer to the problem. Write us for more details.

Magnuson Products Corporation
Manufacturers of Specialized Cleaning Compounds for Industry
50 Court St. BROOKLYN 2, N. Y.
In Canada: Canadian PERMAG Products Ltd., Montreal, P. Q.



UDYLITE FULL AUTOMATIC is key to better plating for Underwood Typewriters

This Udylite Full Automatic Plating Machine is used at Underwood's Hartford Works to plate small parts for the Underwood Electric Typewriter.

Another great name in American Industry—the Underwood Corporation—has found Udylite equipment and processes supply a ready answer to plating problems. Underwood reports—since installation of their new Udylite Full Automatic Plating Machine for Bright-Nickel application to typewriter parts—that rejects have been virtually eliminated and hand buffing operations on many small parts are now no longer required. This is in addition to a substantial saving in manpower over their previous equipment.

The Udylite Full Automatic offers: (1) Modern, simplified design for easy maintenance; (2) Rugged, integrated frame and base for rapid installation and long-lived durability; (3) Hydraulic lift and transfer mechanism for smooth, efficient operation; (4) Independent lift and transfer controls for meeting various plating requirements.

These and many other advantages have made Udylite equipment the first choice of platers everywhere. Let your Udylite Technical Man show you how Udylite methods and machines can bring tangible benefits to your plating operations. Call him in today. There's no obligation. Or write direct to *The Udylite Corporation, Detroit 11, Michigan.*

PIONEER OF A BETTER WAY IN PLATING

THE Udylite CORPORATION
DETROIT 11, MICHIGAN

News about UNICHROME Trade Mark

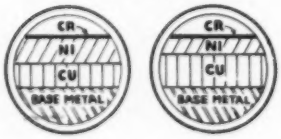
COATINGS for METALS

METALLIC ORGANIC DECORATIVE PROTECTIVE

WAYS TO BEAT SHORTAGES IN METAL FINISHES

Avoid problems due to scarcities by taking advantage of other time tested techniques. For example:

Copper Saves Nickel



not this *but this*

If you are short on nickel, why not use more copper when plating copper-nickel-chromium? You'll still provide the necessary rust-proofing – as so many users of Unichrome Pyrophosphate Copper Process are doing.

Thinner Deposits?

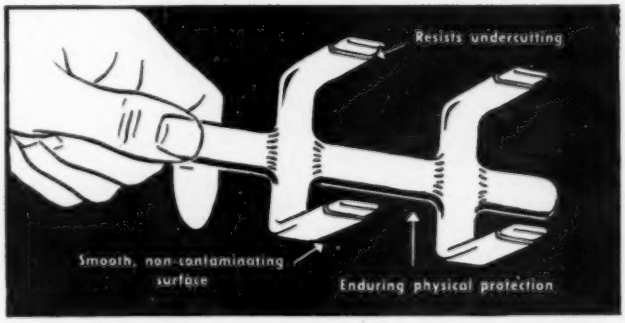
Thinner plate will be found suitable on many products not subjected to considerable handling, if the plated surface is reinforced by a clear lacquer or baked-on finish. Unichrome Clear Product Finishes have been used for years to protect chromium, copper, nickel, silver, brass and many other polished surfaces.

Use Zinc More

It's more plentiful than some metals, and it's inexpensive. When processed in Unichrome Clear Dip, zinc provides a sparkling, sales-appealing finish that looks like chromium and resists corrosion. Such a finish not only costs less, but actually provides better rust-resistance.

Unichrome Plastisol Proves to Be SUPERIOR INSULATION FOR RACKS

- *Because it helps to conserve plating metals*
- *Insures minimum rack maintenance*
- *Goes on faster, with less labor*



How does Unichrome Plastisol Coating 218X accomplish all this? First, it has great durability in all plating cycles; reduces wasteful metal build-up on racks. Second, it bakes into a smooth, glossy coating which rinses freely and helps cut dragout losses, often eliminating expense and delay of reracking for chromium. Third, the insulation withstands abuse. Tough, flexible and substantially thick, it won't tear or chip.

Furthermore, only a single coat of Unichrome Primer 219PX is employed with Coating 218X. Users have found that this system not only saves time, but also insures more lasting adhesion. There are no loose pockets to trap and carry over contaminants – (one of the reasons why Coating 218X is endorsed for leading bright nickels).

The United Chromium service organization will gladly give you full details on this rack coating system – and follow through to see that it is applied so as to deliver its usual long and economical service. Write for more details.

UNICHROME Trade Mark

UNITED CHROMIUM, INCORPORATED

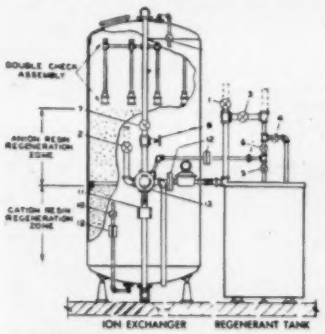
100 East 42nd St., New York 17, N. Y.
Detroit 20, Mich. • Waterbury 20, Conn.
Chicago 4, Ill., • Los Angeles 13, Calif.

In Canada:
United Chromium Limited, Toronto, Ont.

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE # 107.

rust, dirt and moisture from line. For further information, use Reader Service Card.

E—627. Single Tank Water Deionizer—A recently developed single-tank deionizer, a product of Elgin Softener Corporation, Elgin, Ill., is said to give water of higher quality than that produced by two- and four-column deionizers, freer from impurities than distilled water at a fraction of the cost. It will



1 HARD WATER INLET VALVE
2 DEIONIZED WATER OUTLET VALVE
3 SOFT WATER INLET VALVE
4 REGENERANT MAKEUP VALVE
5 REGENERANT SUCTION VALVE
6 REGENERANT RINSE VALVE
7 UPPER MANIFOLD VALVE
8 MID-MANIFOLD VALVE
9 AIR VENT VALVE
10 AIR INLET VALVE
11 EFFLUENT QUALITY CONTROLLER
12 RATE OF FLOW INDICATORS
13 MULTIPORT VALVE

also completely remove silica and carbon dioxide from water—an essential requisite for steam generation in boilers of high pressure type. Whereas specific resistance of good-quality distilled water is 50,000–500,000 ohms, that of water delivered by the Elgin Deionizer is above 5,000,000 ohms, in fact, with careful control, water having resistance over 23,000,000 ohms has been produced.

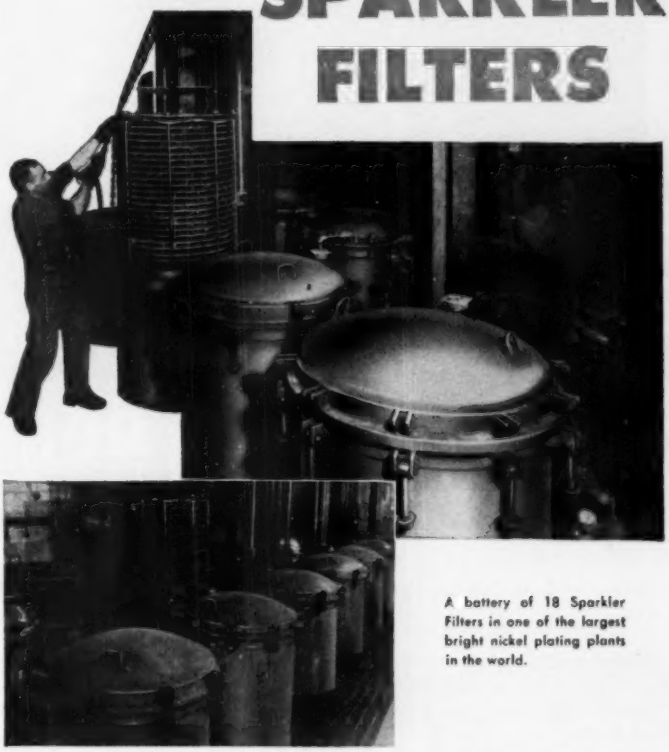
The cation and the anion exchanger resins are intermixed in a single tank. These exchangers have a marked difference in density, which permits them to be divided by backwash into two zones for separate regeneration as illustrated. Each regenerant solution is introduced into its proper zone. For further information, use Reader Service Card.

E—628. Degreaser in Drum—Special equipment to fit into an empty 55-gallon drum (with head removed) to convert it into a vapor degreaser for small metal parts is offered by Manufacturers Processing Co., P. O. Box 6, Detroit 20, Mich.

The unit consists of heating element, work rest, condenser with a corrosion-resistant hood, and controls. The drum in which solvent is shipped can be used for the tank. Enough cleaning solvent is poured into the bottom of the drum to cover the electric heating element by 2 or

NO SHUT DOWN

To Carbon Treat Solution with SPARKLER FILTERS



A battery of 18 Sparkler Filters in one of the largest bright nickel plating plants in the world.

Carbon treatment without shut down is accomplished by cutting out one or two units in a battery of filters, removing the cartridge assembly of filter plates, and replacing with a new plate cartridge dressed with clean filter paper. The proper amount of carbon is mixed with water in a standby tank and recirculated through the filter thus depositing the carbon on the new plates in a cake of uniform thickness and density. The solution requiring a carbon treatment is then circulated through the carbon beds giving the plating solution the carbon treatment without contaminating the tank or stopping plating operations.

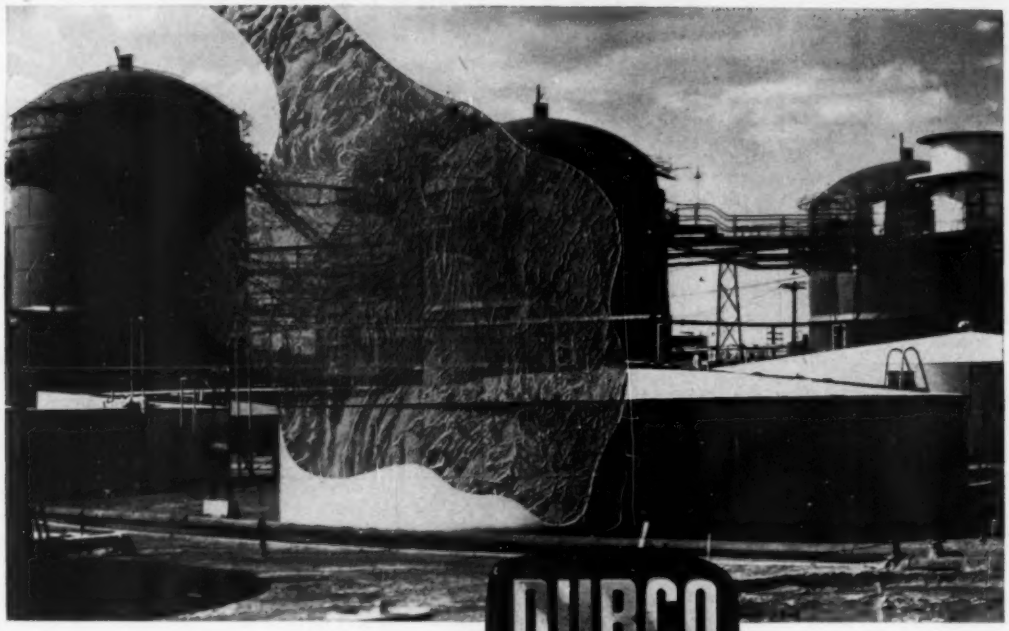
The quick change feature of the plate cartridge in Sparkler filters permits replacing a set of plates in a matter of minutes. Production can be resumed without appreciable interruption.

Sparkler Horizontal Plate Filters give absolutely sharp filtration at all stages of the cycle.

SPARKLER MANUFACTURING CO.
Mundelein, Illinois

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 106.

where corrosion hits hardest...



a team of DURCO CORROSION RESISTING ALLOYS & EQUIPMENT alloys fights it to a standstill

Why does industry consistently come to The Duriron Company with its toughest corrosion problems? A major reason is the wide range of alloys in which DURCO equipment is supplied. DURCO equipment is made in as many as 8 standard alloys . . . and our foundry produces more than 20 different compositions every month.

Why so many?

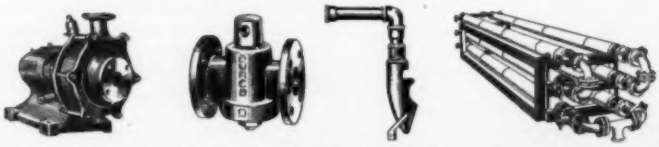
Because the destructive effects of corrosive agents used by industry vary with the agents themselves and with the conditions under which they are used. To be fully effective, the alloy must *fit* the prevailing conditions as well as the corrosive material.

In grappling with corrosive problems for nearly 40 years, DURCO has developed the largest team of alloys ever produced by a single company. That team is always available to industry, together with the technical experience that produced it.

Write, wire or call for information.

The Duriron Company, Inc., Dayton, Ohio

DURCO
CORROSION RESISTING
ALLOYS & EQUIPMENT



DURCO products include PUMPS, VALVES, STEAM JETS, HEAT EXCHANGERS

. . . and get NEW ANODES from YOUR NICKEL SCRAP

You can beat the nickel famine!

Dig into that nickel mine in your scrap bins. Send us those ends, swords, stubs — any nickel anode scrap. We'll cast your own metal into new oval anodes, drill and tap for hooks and ship to you pronto. You paid for this metal; why not use it? It represents a reliable source of nickel at this time and the cost of re-conversion is low. Wagner Brothers, Inc., has installed the finest melting and casting equipment available and your metal is processed under stringent metallurgical control. We're centrally located, easily reached at low transportation cost.

To handle a large volume of metal efficiently, we recommend a standard ordering and shipping procedure. Just fill out the coupon in detail and we'll send full directions for packing and shipping, and quote on any quantity.

Wagner BROTHERS INC.

We have electrolytic nickel anode scrap for re-conversion.

Stubs, average length _____ inches
Weight (less hooks) _____ pounds

Swords, average length _____ inches
Weight (less hooks) _____ pounds

Shipment can be handled in

☐ Strapped bundles ☐ By Rail
☐ Drums ☐ By Truck

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

B.N. cleans around the clock!

For contract or job electrocleaning, here's a real cleaner! B.N. solutions will clean steel, brass, copper, nickel, zinc die castings and more!

Wyandotte B.N. wets fast, cleans thoroughly. It quickly removes fabricating compounds, lint, shop dirt and fingerprints. And because B.N. rinses so freely, you save yourself rejects due to clouded plate. Experienced Wyandotte Representatives are available. When you need technical assistance in your shop, call the nearest Wyandotte man.

WYANDOTTE

B.N.

Direct or reverse current electrocleaner

- Dissolves quickly and completely
- Conditions the water
- Cleans ferrous and non-ferrous metals
- Has good conductivity
- Wets rapidly
- Has long life in solution
- Rinses freely

"Cleaning the World"

THE WYANDOTTE LINE— products for burnishing and burring, vat, electro, steam gun, washing machine and emulsion cleaning, paint stripping, acid pickling, related surface treatments and spray booth compounds. An all-purpose floor absorbent: Zorball — in fact, specialized products for every cleaning need.

Wyandotte Chemicals Corporation
WYANDOTTE, MICHIGAN
Service Representatives in 88 Cities

Wyandotte
REG. U. S. PAT. OFF.

Equipment and Supplies

3 inches. For further information, use Reader Service Card.

E—629. Solution Filter—A new type of filtering membrane for its line of industrial filters has been developed by Titeflex, Inc., 500 Freylinghuysen Ave., Newark, N. J. Designated as the Titeflex "Well-Screen" membrane, it is normally constructed of 316 ELC stainless-steel

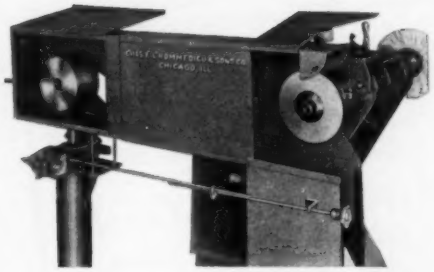
wire formed to a screen of cylindrical shape, which supports the filter cake. Because of the triangular cross-section of the individual wire, clogging is eliminated. In backwashing, the membranes achieve high efficiency because the back-wash flow reaches its highest velocity at the exact point of support of the filter cake. Although developed specifically for use with Titeflex filters, the membranes can be utilized with other types of filtration equipment. They are available in various sizes and can be provided in any alloy which can be drawn into wire. For further information, use Reader Service Card.

E—630. Tumble Descaling—The Magnus Chemical Co., Inc., Dept. P, Garwood, N. J., announces the development of D-Scale-RW, a compound for descaling or derusting iron or steel parts in tumbling barrels. Usually effective in 15–30 minutes, with up to 60 minutes being required in a few cases, it often saves from one to four hours in finishing a load of parts as compared with wet or dry abrasive tumbling. It can be used where parts are self-tumbled or tumbled with abrasive media, is safe to handle, does not give off fumes to cause rusting of equipment or parts, and removes scale completely, resulting in a much better looking part.

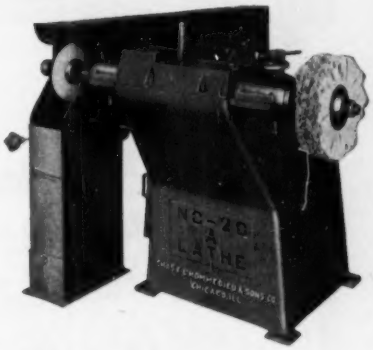
An inhibited-acid-type powder with wetting agent added, it is used hot or cold in concentrations of 4–16 oz/gal, depending upon the amount of scale. As soon as the scale has been removed, fresh

"RELIANCE"

BACK STAND IDLER

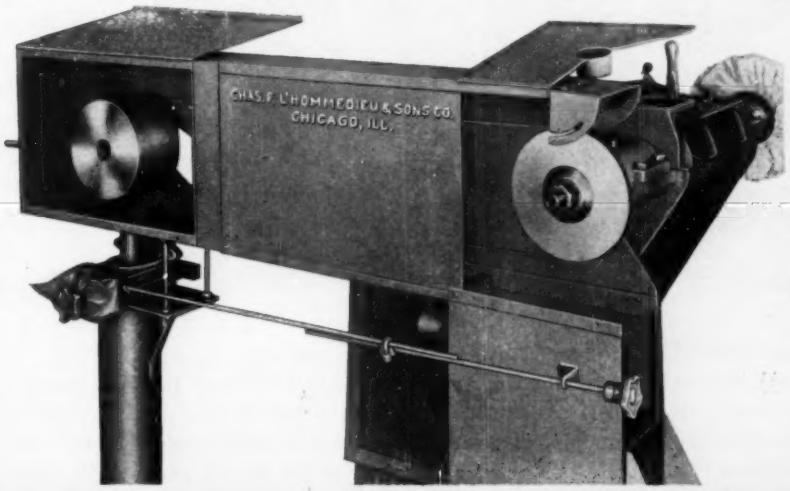


Counter weight with hydraulic shock absorber—takes up slack and provides a tension.



INTERCHANGEABLE FOR RIGHT OR LEFT HAND SIDE. ALUMINUM BALL BEARING PULLEY WITH ROTATING INNER RACE WHICH THROWS THE GREASE ON THE BALL AS IT REVOLVES. PULLEY SEALED ON BOTH SIDES SO NO DUST CAN COLLECT AROUND HUB. ADJUSTABLE FOR VARIOUS LENGTH BELTS.

Write for further particulars if you have special problems.



No shop should be without a "Reliance" BACK STAND IDLER.

Chas. F. L'Hommedieu & Sons Co.

MANUFACTURERS of

Plating and Polishing Machinery

Complete Plating Plants Installed

C. B. Little
Newark, N. J.

W. R. Shields
Detroit, Mich.

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Philadelphia, Pa.

Gen. Office and Factory:
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Cleveland
and
Los Angeles

FORMULA for simplifying alkaline zinc bath preparation

To each gallon of Promat 99M2X prepared zinc electrolyte simply add one gallon of water and 50cc Promat C-42 Addition Agent!
1 Exceedingly simple and foolproof.
2 Operates at current densities from 5 up to 200 amperes per square foot.
3 Fast, highly efficient.
4 Strong throwing power.
5 Excellent fine grain deposit.
6 Very economical!

• Promat 99M2X Zinc is a completely mixed, filtered and purified electrolyte containing all of the standard electrolyte ingredients plus a quantity of Promat C-42 Addition Agent and Promat Doctor Solution Purifier. Easy to prepare and maintain, it is the ideal answer for plants now doing zinc plating, plants entering the plating field and those converting from other metals to zinc. The two times concentrated electrolyte is shipped in 30 gallon returnable drums.

It will pay you to investigate this simple, low cost way to better zinc plating. Write for details today.

It's Promat for Preparation, Plating and Protective Chemicals

PROMAT DIVISION
Poor & Company
851 S. Market Street, Waukegan, Ill.

DISTRIBUTORS

HAVILAND PRODUCTS CO.
Grand Rapids, Michigan

WAGNER BROTHERS, INC.
Detroit, Michigan

DISTRIBUTORS

BART-MESSING CORP.
Brooklyn, New York

REYNOLDS-ROBSON SUPPLY CO.
Philadelphia, Pa.

ARDCO, INC., Chicago, Illinois

water is run into the barrel to flush the parts, excess water is dumped, and 1–2 lb of alkali is added to neutralize the acid solution. The barrel is then run about five minutes and drained. Closed barrels should be vented at intervals to prevent an accumulation of gas pressure. For further information use Reader Service Card.

E—631. Water-displacing Compound—Hydralift is a water-displacing compound developed and manufactured by the London Chemical Co., 607 S. Dearborn St., Chicago 5, Ill., to insure a moisture-free surface on all metals. Used as a cold dip, it instantly forms a molecular film, even in the deepest crevices, lifting the moisture to the surface where it runs off. This film is transparent when dry and can neither be seen nor felt. Coverage is 8,200 square feet per gallon. It is used as a dip, spray, or brush-on after water rinsing, assuring maximum protection during interoperational and short-term finished-product storage. It is said to eliminate the need for water-drying operations with attendant water-spotting, oxidizing and hydrating effect on metal surfaces, to neutralize finger prints, to prevent water stains, and to leave a clean, desirable surface for further plating or finishing. During the dip, the water droplets fall to the bottom of the tank and can be drawn off periodically; the efficiency of Hydrolift is left unimpaired. For further information, use Reader Service Card.

E—632. Filterless Dust Collector—Model 8N50 is the newest addition to the line of Dustkop Dust Collectors announced by Aget-Detroit Co., Ann Arbor, Mich. Rated at 885 cfm with 3-inch static suction, it is recommended especially where outside exhaust of cleaned air is required due to state regulations or to the presence of toxic fumes or vapors. Feature of the unit is portability, immediate installation, and compactness (20 x 30-inch floor space). It is a standard unit available from stock.

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THE MAILBOX

Subject: Analysis of Gold Alloy Solutions

DEAR SIR:

The writers of the Mailbox item in the September, 1950 issue are referred to the article, "Analysis of Gold and Gold Alloy Solutions", which appeared on page 33 of the January, 1947 issue of the Monthly Review, with corrections on page 327 of the March, 1947 issue.

The procedures described in this article were developed in 1944–1945 and since that time have been used daily in the analysis of gold-alloy solutions from hundreds of widely divergent plants. The age of these solutions are from one day to five years, and their daily output varies from a few pieces to 1000–1500 amp-hours.

The effect of copper on the nickel determination is shown in Table IV. Copper in amounts equal to nickel has little or no effect. When the copper:nickel ratio is 2, the error is −4–5 per cent. At higher ratios the negative error increases rapidly, and at 5:1 the results are not reproducible due to the fading of the nickel dimethylglyoxime color. Even the addition of 2–3 times the standard concentration of dimethylglyoxime does not prevent the fading of the color, indicating that the reaction with copper is not the only trouble. It is possible that Mr. Nell obtained greater effects because of the lower acid concentration of his aliquot.

In Table III the effect of ammonia concentration is demonstrated. With increasing concentration, the negative error increases. Mr. Nell added hydrochloric and nitric acids and then hypochlorite followed by partial drying before diluting to 250 ml and taking an aliquot. In the earlier procedure, sulfuric acid was added to the original sample to eliminate cyanides and, incidentally, to precipitate gold. Thus, the same amount of ammonia in the aliquot will lead to different values. It is also important that the bromine water have a uniform strength, preferably by keeping it saturated with some excess liquid bromine in the bottle.

The addition of the sodium hydroxide was found necessary, as without it the nickel dimethylglyoxime color began to fade in 1–2 minutes and continued fading until colorless. The rate of fading appeared to depend on the copper content, small variations in the procedure, and large variations in carbonate and free cyanide contents of the samples. However, with the immediate addition and thorough mixing of strong caustic, the color intensity increased for about two minutes and then remained constant for 24–48 hours. High concentrations of copper (Cu:Ni = 5), however, still produced fading.

The plate from such solutions would be quite pink, but the copper can be removed after the sulfuric acid treatment by electrodeposition. The most recent application of this old method was published in the May, 1950 issue of this journal as part of the procedure for the "Determination of Nickel in Copper Plating Baths" by Dr. Serfass.

Iron is fairly well complexed with citric acid, and the yellow color which large quantities produce has little or no absorption above 500 mμ.

In the phosphate determination little or no trouble develops if the reagents are satisfactory. Rather extensive work on this method appears in the journals serving the biological field, in which phosphorous compounds are extremely important. Mellon has been studying the phosphomolybdate reaction thoroughly. One of his papers appeared in Analytical Chemistry **20**, No. 8, 749 (1948).

Yours very truly,
EDWARD A. PARKER

DEAR SIR:

The extensive studies by Dr. Parker to determine the effects of gold and nickel in the colorimetric determination of copper and of copper in the nickel analysis are very significant. They seem to prove that the colorimetric ammonia method for the determination of copper is adequate even in the presence of considerable amounts of gold and nickel, whereas the interference of large amounts of copper in the colorimetric dimethylglyoxime method for the determination of nickel is quite noticeable. Copper in the amounts present in pink-gold baths lowers the meter reading for the nickel.

In a letter to me J. Mermillod has suggested the adaption of a method by two English chemists, Haim and Tarrant[1], for the determination of nickel in bronze. The main difference between this method and those advanced by Parker[2], Mermillod[3], and myself[4] is that Haim and Tarrant use ammonium phosphite to precipitate the copper before the nickel is determined with dimethylglyoxime. Another deviation consists in the use of iodine instead of bromine for the oxidation of the nickel. Since we are discussing analysis of gold solutions, we have to mention that ammonium phosphite precipitates gold as well as copper.

I have not obtained practical results, reproduceable enough, to recommend this method. However, I feel that further investigation of proper dosage, order of addition of reagents, usage of bromine or iodine, range, general conditions, etc., may lead to a procedure for the colorimetric determination of nickel even when considerable copper is present in the sample.

The colorimetric phosphate determination, on the other hand, in which molybdic acid and 1-amino-2-naphthol-4-sulfonic acid are used as color-producing agents, can be considered well accepted as an easy, quick, and reliable method. A simple variant has been suggested in PLATING[5].

The iodimetric method for gold advanced by Dr. Parker[3] is , no doubt, very valuable. We used it quite successfully for some time and still use it to check results by other methods or where for some reason other methods do not seem applicable. Rochat's aluminum-foil method[6] has the disadvantage of requiring weighing of crucibles. However, in case we want to check results gravimetrically, this method seems very recommendable.

Whereas Parker in his article in 1947[2] says that "it is not yet feasible to determine gold colorimetrically", I suppose he himself considers this statement obsolete in view of the o-tolidine method. Of course, like most other colorimetric methods, it is not fool-proof, and certain precautions to avoid or minimize interference by foreign ions have to be taken. Sandell[7], for instance, mentions the interference of free halides, and I have stressed in my outline[4] that one must make sure that all free chlorine be boiled off before the o-tolidine is added. In another article[8], Dr. Parker makes a remark concerning the effect of copper in the o-tolidine method. I ran a number of checks, which showed that Parker's question was justified. Copper, when present in considerable amounts, does produce somewhat lower readings for gold if the purple filter is used, but with the blue filter the deviation does not exceed 2–3 per cent, which is well within the accuracy we generally expect in rapid determinations of any kind.

Very sincerely yours,
KARL NELL

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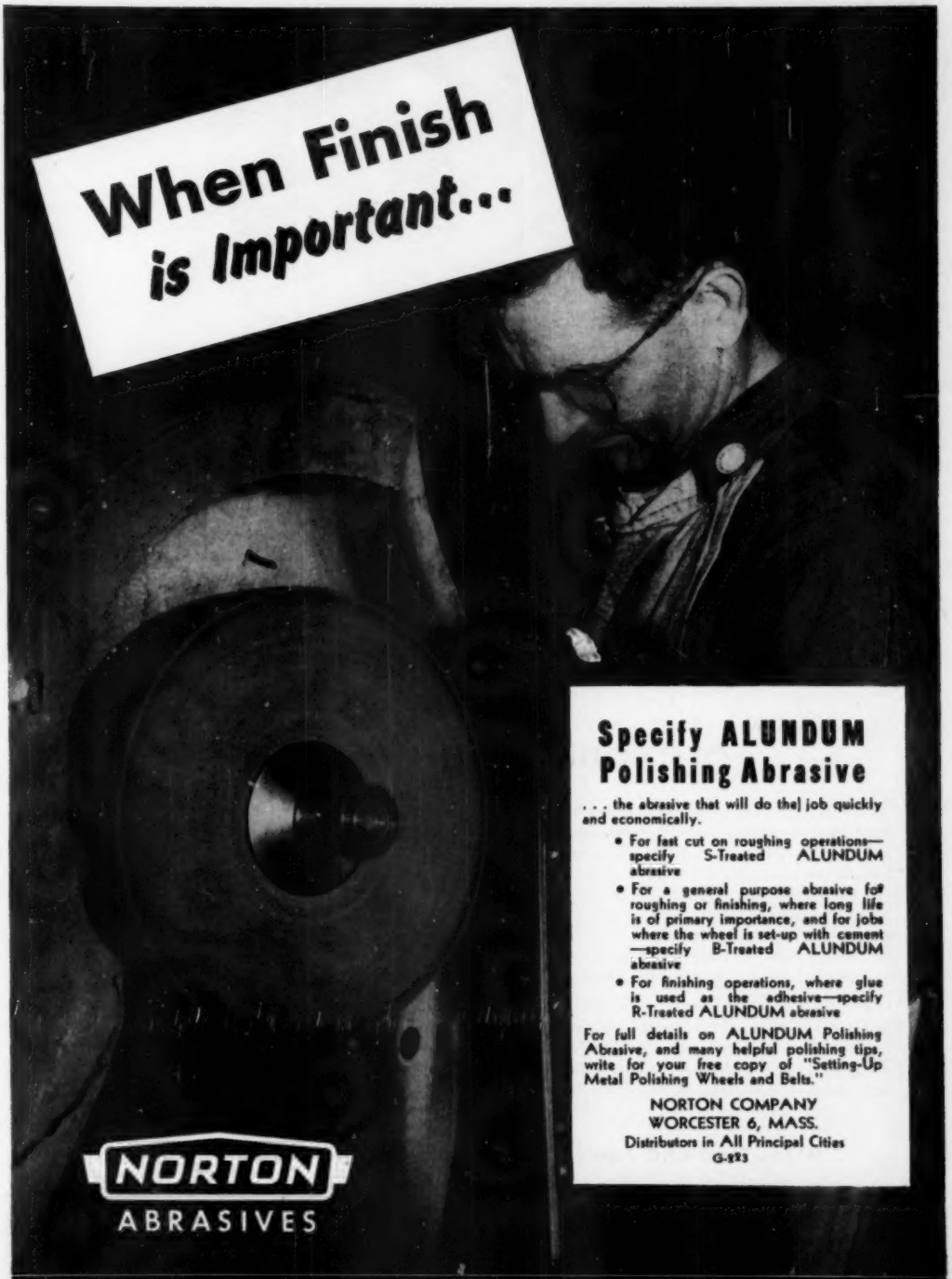

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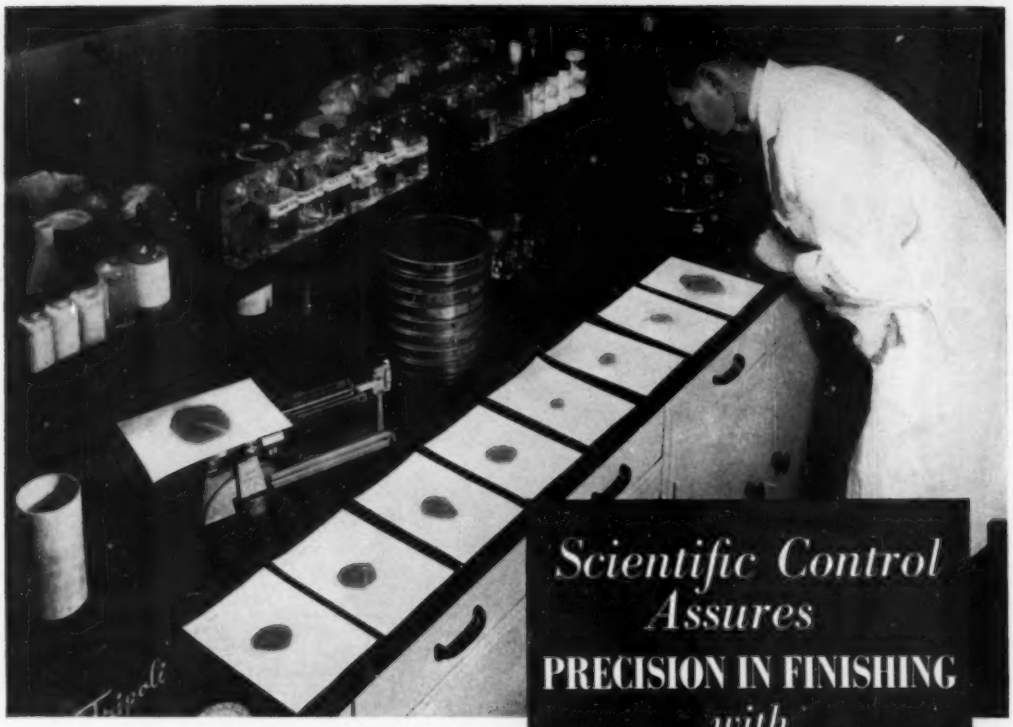

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This month's cover picture shows one of the A. E. S.-A. S. T. M. authorized test lots which have played such a large role in the development of nickel plating (see Dr. McKay's article in this issue). This particular lot is at the International Nickel Company's Harbor Island (Kure Beach) Testing Station, Wrightsville, North Carolina

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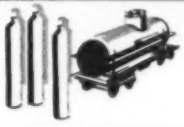

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Editorial

Reduce Dragout and . . .

ONE WAY IN WHICH SUPPLIES often can be stretched further is by reduction of dragout. In some places the saving may be quite considerable; we have encountered plants where the total volume of solution was lost every 1–2 months because the parts scooped out the bath.

It should not be forgotten, however, that dragout fulfills a useful function; it removes not only valuable bath constituents but also impurities. And impurities are likely to enter the bath in the largest quantities just where dragout is abnormally large, because a plant man who is careless with dragout probably also neglects to prevent impurities from entering or forming in the solution.

It is therefore not sufficient to take steps to reduce dragout; the plater must at the same time put into effect various means of reducing contamination. These may include better cleaning and rinsing prior to plating to avoid bringing oil, grease and dirt into the solution; better racking to prevent parts from falling into the plating tank and dissolving there, and more frequent removal of parts that unavoidably drop into it; prevention of overheating of such cyanide baths which decompose easily to form carbonates.

Where these and similar means are insufficient to maintain the desired low level of impurity content, the plater must consider means of purification: filtration, carbon treatment, chemical and electrochemical (dummying) treatments. In some cases he will find that these treatments may be quite wasteful in themselves and have to be modified. At times they may not even pay their way conservation-wise, and it may be more efficient not to reduce dragout to the lowest possible value.

A good look at both dragout and impurities should be taken by everyone who wants his supplies to go further.

Gustaf Soderberg

THE STRENGTH AND DUCTILITY OF ELECTRODEPOSITED METALS

III. Some Problems Relating to Specimen Preparation

HAROLD J. READ* AND THOMAS A. PRATER†

Introduction

So far in this series of papers[1] attention has been focused on the execution of the hydraulic bulge test, the interpretation of test data, and the reproducibility of the results. It had been realized from the inception of the work that the technique of specimen preparation was likely to be of paramount importance. Experience not only has confirmed this thought but has shown that the problems of testing are as nothing compared to those associated with specimen preparation.

The variables encountered in specimen preparation may be divided into two major classifications, i. e., (1) those associated with the bath and the plating variables directly related to it, and (2) those which depend on all other factors involved in plating and testing. This grouping is useful because in the study of the effects of bath composition and direct plating variables (current density, temperature, impurities, etc.), all factors in the second group must be held constant, or the investigator must have an accurate knowledge of their possible influence on the results. In any case, it is necessary to know a great deal about the variables of the second group before those of the first group can be studied to the best advantage.

It should be noted here that many variables of the second group have been ignored or at best given but cursory attention in those investigations of the mechanical properties of electrodeposits which have been hitherto published. It does not necessarily follow that the reported results are invalid or useless. So long as a uniform technique was employed in the preparation of test specimens the results so obtained are susceptible of comparison one with the other. It must be realized, however, that the usefulness of the results is limited by the technique of specimen preparation, and the values should not be compared with those obtained on specimens prepared by other methods.

It is logically evident, therefore, that before any extensive program of testing with the object of providing fundamental data on the *absolute* mechanical properties of deposits can be undertaken, it is necessary to study with some care the variables of the second group. An attempt has been made to list all of the variables which fall into this category. It is very probable that the authors have not considered every possibility, and it is hoped that other investigators will contribute their thoughts on this matter.

Thickness of the Deposit

There is already ample evidence in the literature that thickness is an important variable. The work of Brenner and Jennings[2], for instance, has shown that there is a tremendous effect of thickness on the strength and ductility of nickel deposits which have been plated from the traditional Watts solution. It should be noted, however, that the major variations in tensile strength are found only for thicknesses below 3 mils (75 μ), although the ductility varies over a much wider range of thickness. The thinnest specimen measured by these authors was 0.5 mil (13 μ). If their curve were to be extrapolated to a thickness of 0.1 mil (2.5 μ), the tensile strength for the nickel would become unbelievably large. It is evident, therefore, that at some thickness there must be another point of inflection in the curve of tensile strength *vs* thickness. Brenner and Jennings do not give any ductility values for thicknesses below 1 mil (25 μ), but an extrapolation of their curve for elongation indicates that zero ductility would be attained at 0.3 mils (7.5 μ). It should be mentioned, however, that another curve could be drawn through their points which would indicate appreciable ductility at zero thickness. The great advantage of the bulge test is that it permits the critical examination of both tensile strength and ductility in the thickness range of greatest interest for protective and decorative coatings, namely 0.1 to 3 mils (2.5 to 75 μ). Some work which has been done in this laboratory and which will be reported in detail in a later paper indicates that in this range of thickness

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the variations in ductility are far more marked than the variations in tensile strength.

Nature of the Basis Metal

Inasmuch as the influence of the basis metal usually decreases rapidly as the thickness of the deposit increases, the nature of the basis metal probably has little effect on the mechanical properties of thick deposits. There is little doubt, however, that it is a variable of major importance for deposits of the thicknesses used in protective and decorative plating. In this connection one must consider not only the composition of the basis metal but also its physical state, e. g., hot-rolled, cold-rolled, mechanically polished, electropolished, bright-plated, buffed, etched or unetched, etc., *ad infinitum*. It is obvious that much work will be required to explore fully the many facets of this complex variable.

The problem of hydrogen in the basis metal cannot be neglected. Many cleaning operations, particularly cathodic electrocleaning and mild acid dips, are conducive to the formation of occluded hydrogen in steel and other ferrous alloys. The same situation with respect to hydrogen formation may be encountered in the cleaning or other pretreatment of zinc and aluminum alloys. The entire cycle of cleaning and the temperatures and times involved therein may well be important in their effect on the mechanical properties of the deposits. If the specimens are stripped from the basis metal, the elapsed time between plating and stripping might well affect the extent of the influence of hydrogen in the basis metal on the properties of the deposit. Other complications of this sort can readily be suggested. The evaluation of the significance of these factors will not be an easy task in view of the complexity and variety of pretreatments which are in common use. It is only to be hoped that they will prove to be of minor importance.

Post Treatment of Deposits

It appears to be inconceivable that the measurement of the mechanical properties of thin deposits would be unaffected by drastic post treatments such as buffing or coloring. Heating effects, the flow and fragmentation of metal at the surface, the introduction of local stresses and variations in thickness resulting from nonuniform metal removal are some of the factors which might influence the mechanical properties.

It may well be also that a less drastic treatment such as a bright dip, a conversion-coating dip, or the electropolishing of the deposit will affect the mechanical properties of the deposits to some extent. It will be necessary to take into account the possible effects of any post treatment when the mechanical properties are being determined for the purpose of correlating them with the service behavior of the coating during outdoor exposure or other performance tests.

Multiple Coatings

It may not be proper to judge the properties of multiple coatings, such as copper-nickel-chromium on steel, from results obtained on specimens of the individual metals. The work of Clifton and Phillips[9] indicates that it would not be safe to do so, but their data are limited to measurements of tensile strength whereas variations in ductility may be more important.

The hydraulic bulge test is particularly suited to the study of this problem, both because of the simplicity of specimen preparation and the sensitivity to variations in ductility.

It must be remembered also that the relative thickness of each metal in the multiple coating is likely to be an important factor.

The internal stresses in the components of a multiple coating will inevitably be of different magnitudes, and may even vary in direction. These stresses will influence the measurement of mechanical properties of the deposit and may well have interactions which will not be susceptible to mathematical analysis when the several deposits are tested individually. Consider, for example, the case of cold-rolled steel plated with copper and nickel. The surface of the steel will contain compressive stresses, the copper may be under tensile stress, and the nickel could well be stressed in compression. These internal stresses could be evaluated for each metal, but the deduction of their combined effects on the complete coating is not possible. The use of composite test specimens is indicated.

It is interesting to speculate on the effects of multiple coatings on the behavior of hydrogen which may be occluded in the basis metal during the cleaning cycle. In the case of a chromium-nickel-copper-steel system, the copper would serve as a barrier for the diffusion of hydrogen to the outer surface, whereas no such barrier would exist in a chromium-nickel-steel system. The aging effects would, therefore, be quite different in the two systems, and might be reflected in the mechanical properties.

Separation of Deposit from Basis Metal

In the determination of the mechanical properties of electroformed metals there is no problem of specimen isolation in that plating under nonadhesive conditions is an integral part of the electroforming process. For all adhesive protective and decorative coatings, it is necessary to determine whether or not the provisions made for separating the test specimen from the basis metal have introduced factors which no longer make the test results reliable.

There are three ways in which specimens may be prepared, namely, plating under nonadhesive conditions, selective dissolution of the basis metal, and deposition on thin samples of the basis metal for testing of the resulting composites. Which of these methods gives the most significant results will have to be determined.

When nonadhesive conditions are used it is probable that the structure of the specimen is affected thereby. Any diffusion effects, whether they be gas-solid or solid-solid, will be influenced by the nature

of the barrier which causes lack of adhesion. These and other phenomena could affect the mechanical properties of the deposit.

Any technique which is used to prepare specimens by the selective dissolution of the basis metal must be examined for its possible effects on mechanical properties. Such effects are most likely to be caused by slight but selective etching effects, e. g., grain-boundary attack, or by gas absorption. Some combinations of plated coating and basis metal, such as nickel on steel, present serious problems in the selection of a reagent which will preferentially dissolve the basis metal.

In some cases it is difficult to carry out experiments involving composites of the coating and the basis metal. It would be impossible to prepare a plated zinc-base diecasting thin enough to test as a composite specimen. If composite coatings are tested, the effects of the ratio of coating thickness to basis metal thickness must be determined. Here again a great deal of work will have to be done before solid ground is reached.

Effect of Imperfections in the Specimen

Inasmuch as it is difficult to prepare deposits which are consistently free of pinholes, their influence on test results must be evaluated. These defects occur in commercial coatings, and any effects they have on mechanical properties will be of considerable practical interest.

It is necessary also to consider the possible effect of other imperfections in the deposits; for example, is it possible that a pit which extends part way through a deposit will serve as a "notch" or stress raiser which will lead to premature failure in the bulge test or other test? Other imperfections such as scratches, localized dull areas in an otherwise bright deposit, and nodules may all have greater or lesser effects.

Another type of imperfection which must be kept in mind is the variation in thickness from point to point in the deposits which are used as test specimens. The uniformity of loading during any test is greatly affected by this factor, and it is extremely difficult to obtain deposits of uniform thickness from some plating solutions. The cyanide-copper baths are particularly troublesome in this respect, and it is difficult to prepare deposits from them with variations of less than ±10 per cent in thickness. On the other hand cyanide-zinc baths yield deposits that are remarkably uniform.

Rate of Loading

It may be found that in the evaluation of the mechanical properties of deposits for engineering uses the rate of loading in either the bulge test or the traditional tensile test is an important factor. Consider, for example, the evaluation of plated strip steel which is to be used in forming operations. Such operations, whether they be pressing, stamping, or drawing, are executed at a rate which is far in excess of the usual loading rate in a mechanical-property test. It could well be that the behavior of the deposits at high loading rates is not the same as at the lower rates. If this be true, it will be necessary to take into account, when the conditions for testing are specified, the ultimate use for which the test data are desired. It is true that the testing difficulties are considerably increased when rapid rates of loading are used. It is particularly difficult to measure the strain when the load is applied rapidly, but the problem is not insuperable and can be solved if necessary.

Aging of the Specimen

At least for some metals such as iron, chromium, and nickel, there is ample evidence that hydrogen may be occluded in or combined with the deposit and that the hydrogen subsequently diffuses from the deposit. If the hydrogen has any effect on mechanical properties, the properties will vary with the elapsed time between the preparation and the testing of the specimen because the extent of diffusion from one body to another or the attainment of a state of equilibrium is strongly dependent on time. The time factor, in turn, is highly dependent on the nature of the system and may vary widely.

Inasmuch as temperature, as well as time, is an important factor in any diffusion process it is obvious that this variable must always be taken into consideration.

Although there is some indication in the literature that the effect of hydrogen on the mechanical properties of deposits may not be so important as was once thought to be the case, more work is needed on the general problem, and for the time being at least, this factor cannot be neglected in specifications for methods of specimen preparation.

Future Work

Some exploratory work relating to these problems will be presented in succeeding papers. Only the surface can be scratched with the time and man-power available in this laboratory; but attempts will be made to discover the most important variables so that these may be investigated in detail, either in this laboratory or by other investigators who may find the problems of interest and importance.

It must be recognized that knowledge in this field is extremely sparse. It will be necessary to do a great deal of exploratory work on the problems discussed herein before it will be possible to realize the greatest value from investigations of the effect of variables of the first group, as defined earlier in this paper, on the mechanical properties of deposits.

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PLATING FROM COPPER CYANIDE BATHS

Typical copper cyanide bath compositions are given in Table I. The operating conditions for these baths are given in Table II.

The bath compositions may be varied from those given. Specific information on baths 3, 4, and 5 may be obtained from the companies offering these processes. It is well to remember that baths of higher copper concentration, under conditions of operation usually employed, have higher cathode and anode efficiencies. The free cyanide concentration may be varied from 0.5 to 1.5 and 2.0 oz/gal. However, increasing the free cyanide will increase the anode efficiency and decrease the cathode efficiency.

It should be noted (Table II) that the higher-metal baths operate at higher cathode current density and higher temperature. In general, the cathode and anode efficiencies increase with increasing temperature and decreasing current density. The higher current densities will give satisfactory deposits provided the bath temperatures and degree of agitation are relatively high.

Possibly the most limiting factor in plating from copper cyanide baths is the anode efficiency. This is due to a tendency for insoluble compounds to form on the anode surface which reduce the current flow and the anode efficiency and causes serious roughness of the deposit. A practical solution to this problem is to reduce the anode current density to a value of 10–15 asf, the lower figure being necessary for the baths of lower copper concentration. This is accomplished by using an anode area two to three times the size of the cathode area. A high temperature, a high metal content, agitation, and a free-cyanide concentration at the upper allowable limit favor good anode performance.

An "insoluble" iron anode, of an area up to about 5 per cent of the total anode area, has been used as a

TABLE I. TYPICAL CYANIDE COPPER BATHS

Bath Composition	No. 1	No. 2	No. 3	No. 4	No. 5
	Low Copper oz/gal	Rochelle Salt oz/gal	"High Speed"* Potassium oz/gal	"High Speed"* Sodium oz/gal	"PR" Copper† oz/gal
CuCN, added	3.0	3.5	8.0	16.0	10.0
NaCN, added	4.5	4.6	12.5‡	18.0	12.6‡
Copper	2.1	2.5	5.6	11.3	7.0
Free NaCN	1.0	0.75	1.0‡	0.5	1.0‡
Na_2CO_3	2.0	4.0	....	....	2.0
NaOH	To *p*H▲ 12–12.6	To *p*H▲ 12–12.6	5.6‡	4.0	6.0‡
Rochelle Salt	.....	6.0	....	....	....
Additions	●	.....	RH774 0.2	RH556 0.2 NaCNS 2.0	Wes-X

*duPont.
†Westinghouse, used with various cycles of periodic reversal of direct current
‡Potassium compounds
▲Colorimetric *p*H
●Lead (0.003–0.004 oz/gal) or "Hypo" ($Na_2S_2O_3.H_2O$) have been added to brighten the deposit but are not recommended for copper strike

TABLE II. OPERATING CONDITIONS

Bath No.	Temp °F	Cathode Current Density asf	Agitation	Cathode Efficiency %
1	90–110	10–15	Rod	30
2	130–160	20–60	Rod	50
3	170–180	30–60	Rod	100
4	170–180	30–60	Rod	100
5	180	30–80	Rod + Air	100*

*Without PR current, less depending upon PR cycle employed.

further means of reducing the polarization of the copper anode. Unfortunately, iron is attacked at current densities above 10 asf, especially if the *p*H is below 12.0, and ferro- or ferri-cyanides which form in the plating bath will ultimately reduce the efficiency of depostion. Also, at current densities sufficiently high for the iron to carry current, cyanide will be oxidized to carbonate. This increases cyanide consumption and causes the carbonate concentration to build up. High-purity electrolytic, rolled, cast or extruded copper anodes, with no insoluble anode area, are preferred.

When carbonates exceed 8 oz/gal it is best to lower their concentration to about 2 oz/gal. Potassium carbonate is claimed to be less objectionable at high concentrations than the sodium salt. In either case, however, excess carbonate may be removed by using one of the following methods:

1. Lower the bath temperature below 32° F to cause a hydrated carbonate to crystallize out and remove it by centrifuging or by decanting and filtering.

2. Add soluble barium salts such as cyanide or hydroxide to precipitate insoluble barium carbonate. Equivalent alkali cyanide or hydroxide will remain in solution. The barium carbonate must be removed by filtration. Barium hydroxide is preferred by many, particularly for baths requiring a high hydroxide concentration such as baths 3, 4 and 5 in Table I.

Deionized or softened water is recommended for making up baths and replacing drag-out or evaporation. Hard water causes formation of sludge, as well as dull and rough deposits.

Continuous filtration is recommended to obtain smooth deposits. Filter aid (wood pulp, preferably) should be used for best results. Carbon may also be used to remove objectionable organic contamination. It will also remove some addition agents of the types used in baths 3 and 4.

For plating heavy, smooth copper coatings from cyanide baths, anode bags or cloth diaphragms are now commonly employed. They prevent solid particles from the anode from causing rough deposits.

For a strike, to deposit copper 0.0001 inch in thickness on a ferrous base metal or on zinc-base diecasting, baths 1 or 2 may be used. For bright copper deposit under bright nickel, or for deposits over 0.0001 inch in thickness, the strike is usually followed by a bath similar to 3, 4, or 5. The Rocheltex (MacDermid, Inc.) copper bath, which is a modification of bath 2 with an addition agent, may also be employed. Bath 5 with PR current is capable of depositing very heavy, smooth, bright copper with good leveling. Wico Brite copper bath (The Wire Coating & Mfg. Co.) is similar to bath 4 with the exception that 50 ml of WCM Brite Copper serves as the addition to each gallon of solution.

Chemical control of cyanide-copper baths is a must for quality plating. The *p*H and free cyanide must be closely controlled by analysis, once daily in most cases. The metal content must be checked once or twice a week depending upon how heavily the bath is used.

✣ Carl E. Heussner ✣

Carl E. Heussner, Materials Engineer of the Chrysler Corporation, Detroit, and during many years a leader in the electroplating industry, passed away in his home in Birmingham, Mich., on January 2 after a prolonged period of failing health. He was only 51 years old.

Few men have been able to look as critically at his own industry as Heussner did at the plating industry, and few have been so unrelenting in trying to improve it and make others conscious of its needs.

One of Heussner's outstanding contributions is the reorganization and refinancing, in 1945, of the Research Committee of the American Electroplaters' Society, in which he was a driving force. It will remain a monument to his foresight and organizing ability.

He pioneered in the development of plating and other finishing specifications and was one of a small group responsible for establishing, in 1941, Committee B-8 on Electrodeposited Metallic Coatings of American Society for Testing Materials.

He was also conspicuously identified with promotion of the use of zinc-base diecastings and improvement in their quality through various society committees, and served as consultant on these matters to the War Production Board during the last war.

Heussner was born on September 15, 1899, on a farm in northern Michigan. After attending a country school and the high school in Marlette, Mich., he enlisted in World War I. Following the war, he went to Albion College, University of Michigan and Wayne University, originally studying medicine but later turning to engineering. He joined the Chrysler Corporation on leaving school and remained with it throughout his life. For many years he suffered from hypertension, for which he underwent a very serious operation about ten years ago, and from other bodily ailments. The immediate cause of death was heart failure.

Services were held in Woodlawn Chapel on January 4. Among floral offerings was one from the American Electroplaters' Society, which was represented by First Vice-President C. F. Nixon.

Beside his beloved wife, Helen, stand mourning a large number of friends throughout the country and in foreign lands. He will be sorely missed.

THE HISTORY OF NICKEL PLATING DEVELOPMENTS IN THE U.S.A.

R. J. McKAY

The International Nickel Company, New York, N. Y.

(Continued from the January Issue)

SECOND MILESTONE—Mechanical generation of current

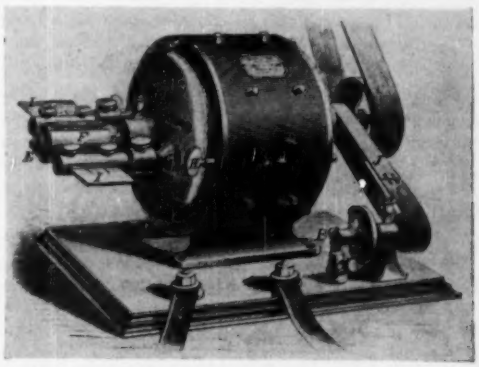
In 1874 Edward Weston, who was a consultant for the Condit, Hanson and Van Winkle Company, began the manufacture of low-voltage generators for plating. Dynamo-generators had been gradually developed in Europe from the first magneto-type machines of Woolrich and were just becoming practical. These machines were accepted at first with considerable skepticism; there was a real doubt as to whether the current generated by them had the same properties as the current obtained from batteries, which had formerly been the more common source of current. It was found that the "Weston Instruments" worked satisfactorily, and the modern machines evolved from early types are now indispensable in commercial plating.

THIRD MILESTONE—Boric acid

Edward Weston patented the addition of boric acid to the nickel plating bath in 1878. This innovation, which has now become one of the necessities in nickel plating, seems to have come into use with little comment in the scientific literature. Possibly the reason was that the true significance was not understood; its effect as a buffer was not known, the discovery being purely empirical.

Stopping for a moment to take stock, we can look back on a period of quite rapid development during the 15 years that had preceded this invention. Nickel plating was one of only three uses for nickel, the other two being the alloy then known as German Silver, and nickel coinage. The general public had heard a good deal about nickel plating and was interested in it. It was customary to call articles or projects of a handsome and admirable character "nickel plated"; for instance, the New York, Chicago and St. Louis Railroad, organized between 1880 and 1882, was often referred to as a "nickel plated" job because of its superlative financial and engineering backing. The railroad was nicknamed "The Nickel Plate Road", and although the origin of the term was formally accepted as the brainchild of the editor of the Norwalk, Ohio, *Chronicle*, there were some 40 claimants to this honor because of the common use of the expression. At the finish of construction a nickel plated spike was driven at a ceremony at the Belleville, Ohio, roundhouse.

The principal uses for plating were apparently in the finishing of bicycle and stove parts. The nickel was largely furnished by Joseph Wharton, whose Joseph Wharton Company was one of the antecedents of The International Nickel Company. Wharton was an interesting character, being one of the typical "rugged individualist" industrial leaders of that day. R. C. Stanley, dean of the nickel industry, recalls from his early days in Wharton's Camden, N. J., nickel works that the general manager of the works was a great horse fancier. When he tried to please the big boss by meeting him at the ferry with a spanking team of bays, Wharton gruffly told him that if he could afford



Early Weston "dynamo-electric machine" from title page of Condit, Hanson & Van Winkle catalogue of 1879

to drive a team like that his salary must be too high.

The mining of nickel at Copper Cliff in Canada, the present major source of supply, began in 1886.

Bicycles were fairly well known in 1875, having developed gradually from the foot-propelled models of the early 19th century. They were mainly of the high-wheeled type with 48- and 50-inch diameter front wheels. The so-called "safety" bicycle was invented in 1876 and in a few years spelled the doom of the spectacular high wheel. The great popularity of bicycles grew to a peak in the last years of the century and then dropped off with a crash, apparently partially because of improved interurban transportation. The popularity of the nineties never returned, in spite of such activities as those of "mile-a-minute Murphy", who rode a mile in a minute in the air draft behind a Long Island R. R. train. The following advertisement appeared in *Bicycling World & Archery Field* (1880):

BOSTON NICKEL PLATING CO.

EXCLUSIVE LICENCEES FOR BOSTON OF THE UNITED NICKEL COMPANY OF NEW YORK, 13 AND 15 BOWKER STREET, BOSTON. BICYCLING WORK A SPECIALTY

The bicycle thus became a meal-ticket for the electroplater, but unfortunately the thicknesses used were not sufficient, the cleaning processes were unsatisfactory, and the public gained the general idea that nickel plated parts would at best rust quickly and might be expected to blister and peel—an impression which still exists among both laymen and engineers not acquainted with modern plating developments.

The prophet who could look forward in 1880 would have seen about thirty-five years in which there was little or no advance in plating technique. The plater had at his disposal four major tools which are all in use today, namely, the carbon-bearing cast anode, the low-voltage generator, boric acid, and the double-salt bath, but he did not have the knowledge of their real effects which enables us today to use them or leave them alone as we wish. At the end of this period the American Electroplaters' Society was formed, and O. P. Watts was beginning his interesting work at the University of Wisconsin. Langbein's *Electrochemistry* was translated from German, and many papers on plating were given and discussed before the American Electrochemical Society.

In 1913, O. P. Watts surveyed the plating solutions used or proposed for use in nickel plating, and briefly described ninety different formulae classified as follows:

I. Single Salts
II. Double Salts
III. Miscellaneous
IV. Malleable Nickel
V. Thick Deposits
VI. Additions for Smooth Deposits
VII. Electrotypes
VIII. Nickeling Zinc

Besides the common ingredients of modern baths these baths contained nickel acetate, benzoate, borate, citrate, lactate, nitrate (not good), propionate, salicylate, sulfocyanide (dark deposit), tartrate, formate, "ammonio-ferricyanidem" phosphate, prophosphate, fluosilicate, or ethyl sulfate. Thirty-one of the combinations had been described or tried by Alexander Watt in 1889.

FOURTH MILESTONE—The Watts bath

In 1916, O. P. Watts studied and described "Rapid Nickel Plating" with the hot nickel sulfate-chloride-boric acid bath which has borne his name to the present day. He advocated the use of 125–150 asf (13.5–16.2 amp/dm²) instead of the 10 asf (1.1 amp/dm²) then considered "rapid". At that time "one hour at 10 amps was considered good nickeling" (about 0.0005-inch or 13 μ).

His paper was given at a time when the "remarkable work" by Kalmus and Barrows of plating with cobalt at 150 asf (16.2 amp/dm²) (1915) was making platers think of turning from nickel to cobalt as a coating. In the discussion of this paper, C. G. Fink exclaimed, "Dr. Watts saves the day for nickel". Dr. Watts stated that the presence of any chloride in the bath, besides giving good rapid plating, "is a well known remedy for passivity of the anode", but he claimed that the chief utility of nickel chloride was in the production of a good deposit.

One of his principal pleas was for the use of *hot* solutions, and he described mixtures of "rapid nickel salts" recently imported from England as "only mixtures capable of yielding more *concentrated* solutions than that *enemy of progress*, the double sulfate, which for so long has masqueraded as the plater's friend".

The action of boric acid was well known, but the effect of total acid concentration as contrasted with *p*H was incompletely understood. In fact, at this time the true meaning of hydrogen ion concentration in various phases of chemistry was just becoming widely known through the work of such men as W. M. Clark, Joel Hildebrand, and others. This knowledge paved the way for the fifth milestone.

FIFTH MILESTONE—pH control

Writing in 1921 about the use of fluorides in the deposition of nickel, William Blum discussed the effect of hydrogen ion concentration, or *p*H, and in 1922 M. R. Thompson wrote a full discussion of the subject. In 1925 W. A. Mudge of The International Nickel Company described the use of the hydrogen electrode, the conventional method for measuring *p*H at that time, as adapted to nickel solutions. As a result of experiments started by the writer in 1919, this method was first used in 1920 for the control of hydrogen ion concentration in the nickel-refining solutions of The International Nickel Company. The LaMotte colorimetric indicators and buffered standards, which were brought out in the early 1920's, were a great boon for *p*H determination by the plater, and complete control was common by 1929. In 1930 W. M. Phillips proposed his now widely accepted method of rapid plating at low *p*H.

Contemporaneously with the development of *p*H

control the period of sound technical development, which had begun with the Watts bath a few years before, really got into high gear. The first edition of Blum and Hogaboom's *Principles of Electroplating and Electroforming* appeared in 1924, and the combination of scientific and practical knowledge presented therein and in subsequent editions has been a godsend to platers up to the present day. These authors have been progressive personal forces in the industry—Mr. Hogaboom by his many practical contributions, and Dr. Blum by his scientific pioneering and judicial friendly open comment and suggestion.

Nickel anodes were being improved. The Watts bath permitted the use of pure nickel instead of anodes containing 90–92 or 95–97 per cent of iron. The impure anodes dissolved more readily but caused trouble from iron contamination in low-*p*H baths. Several anode manufacturers produced carbon-bearing nickel anodes of 99 per cent purity. The film which forms around these anodes prevents rough work caused by the separation of finely divided metal and other particles from the anode. Oxidized-pitch anodes dissolved very readily and uniformly but were sluggish and difficult in the casting process. The practice of using anode bags increased, and the quality of the bags was improved. Electrolytic nickel became available in large quantities at the base nickel price, and was a pure material which might be used for anodes although only at the sacrifice of much ease of handling and security with regard to the quality of deposit.

Rolled depolarized anodes were patented in 1930 by Harshaw, Savage and Bezzenberger, and production began in The International Nickel Company's mill at Huntington, W. Va., in 1929. The Phillips bath worked better with the carbon-bearing anodes, and the wide acceptance of the low-*p*H bath carried with it an increased use of the carbon-bearing anode.

The first automatic plating machines had been built about 1920, and in 1923 the A. P. Munning Company began to take up their production in a serious way. From a quiet and gradual beginning this business has increased until the many mechanical improvements introduced by the Munning Company and others have become essential to modern production where high speed is as necessary as high quality.

In 1924 E. M. Baker and Richard Schneidewind described the processes of cleaning with alkaline cleaners before nickel plating, and in 1925 Charles P. Madsen patented the anodic treatment of steel surfaces in sulfuric acid as a preparative step for nickel plating. The great value of these improved cleaning and activating processes was not entirely realized at the time. It is only since the advent of chromium plating and the increased use of nickel plating which has accompanied chromium and bright plating that the use of these processes to produce reliable and complete adhesion has been proven essential. The "Madsenell" treatment developed more rapidly in the United Kingdom than in the U. S. A.

Madsen also patented the use of hydrogen peroxide as an anti-pitting agent in 1924, but again development was slow. The use of peroxide was not considered essential until rapid low-*p*H plating according to Phillips became common. The advent of bright plating, in which wetting agents were more suitable for the prevention of pitting, curtailed the use of peroxide.

SIXTH MILESTONE—Chromium plating

Practical chromium plating had its inception in the 1920's, partly as the result of discussions in the literature by Sargent (1920) and Schwartz (1923). Commercial use began with the hard plating of valves and special parts in the automotive industry and the decorative plating of the plumbing in the new Presbyterian Medical Center in New York. By 1927 or 1928 the use of chromium was quite common on automotive trim and was finding favor elsewhere. An amusing anecdote of this period is told with respect to the founding of the Chromium Corporation of America in 1926. It seems that a New York broker at that time received an order from a good customer to buy 1000 shares of Chromium Corporation and sell 1000 shares of International Nickel short! The writer well remembers that it was generally considered that chromium plating would largely replace nickel plating. The International Nickel Company was one of the early users of hard chromium; it began to use chromium on tube-drawing dies in February, 1927 as licencee No. 12 of United Chromium. How wrong we were in predicting the effect of this technical advance on the future of nickel plating.

Chromium plating illustrates how one advance catalyzes another. It provided the first coating other than the noble metals to be really unaffected by weather. It provided a new and pleasing color, and owing to its high stress, which may be considered an imperfection, it strongly catalyzed the movement toward better cleaning and preparation of base metals. This resulted in the modern high standards of adhesion and the improvement of many types of plating.

SEVENTH MILESTONE—Bright nickel

About ten years after chromium plating had become common practice, bright-nickel plating was widely introduced. In 1920 Todd and King[9] had patented a "bright mirror like" plate and the use of gum tragacanth to produce the effect, but this and a number of other early attempts at bright plating were only moderately successful. The first process to receive wide attention was that of the Pyrene Manufacturing Company which was based on the Schloetter patent of 1932. This process seems to have been rather difficult to control. For historical purposes it is sufficient to note that since about 1937 several practical processes have been patented and made available for use by any plater. The bright processes have had a tremendous effect in lowering the cost and improving the quality of nickel plating.

Present Status and Prospects

This brings us so close to the present day that overall progress is obscured by immediate detail. The results of research and experience, old and new, have given us many tools for the production of more and better electrodeposits. We can look back to 1905, as Adams did at that time to 1865, and conclude that we are in better shape to do a good job. But we are not through with learning and development. We have a larger research program before us now than ever in the past, and we shall need better tools and better control of them to keep electroplating advancing with other metal-finishing and metal-working. Let us look at some of the things now going on which will aid future development.

The recent rapid increase in the use of nickel for plating has been largely in the production of durable bright decorative coatings on steel, brass and zinc-base diecastings. There are, however, many other potential uses outside the field of durable decoration for good nickel electrodeposits.

Research by suppliers

As Dubpernell has shown in the May, 1948, issue of Plating the profit motive is a strong incentive for research enthusiasm. The distributors who are handling nickel-plating supplies have experience which makes them particularly able to take care of the platers' daily needs in distribution and service. Their laboratories rank with the best in the industry, and among their research and service men are many of those who have contributed appreciably to recent progress both scientifically and practically. This efficient distribution machinery should help future progress.

The major raw material for nickel plating, anodes, is better standardized and more reliable in behavior than ever before. The rolled depolarized type gives satisfactory service in high-*p*H baths without introducing large amounts of iron or other impurities. Rolled carbonized anodes have become by far the most widely used type in recent years. Their action is uniform in high-speed low-*p*H baths of all types, including bright and "semi-bright" baths. They are under close control by the manufacturer with respect to their smooth-corrosion range, effect on *p*H control and sludge production. The best types of cast carbonized anodes are close competitors in performance. Electrolytic-nickel anodes are now available, and this lower-priced material has found some favor among platers who are willing to fabricate convenient sizes and shapes, modify their baths to suit the anode, and exert the vigilance necessary to prevent damage which may occur because of unavoidable variations in the nickel refining process. The ultimate effect of electrolytic-nickel anodes on plating quality is questionable and might hinder the present advance.

Automatic equipment for both plating and polishing is being improved in quality and scope on complicated production jobs. This important source of cost savings will continue to aid the plater in overcoming competition from other decorative and corrosion-resisting finishes, and will assist him in metal-working procedures of the fabrication type.

Bright-plating processes have substantially decreased the greatest cost factor in plating, namely, polishing and buffing. Other improvements such as electropolishing, high-quality base metal, improved dies and machines, and better tumbling procedures have contributed to the reduction of polishing costs. Much remains to be done, however, before the ideal goal of virtual elimination of polishing work is reached.

Technical societies

The American Electroplaters' Society was formed in 1913 from the older National Association of Electroplaters of 1909. It would be presumptuous to try to describe this organization and its world-wide influence on electroplating. Most readers of Plating are familiar with the general activities: the branch meetings, regional meetings and annual conventions, the finishing exposition, the journal Plating, and the Research Reports. I want to mention particularly the Research Committee as typical of the things the Society is doing for the present and future good of the industry. This committee was formed in 1927, and after a period of dormancy during the war was rejuvenated in 1944. A great deal of thought was put into the selection of men of ability and experience in research, and Carl E. Heussner was elected chairman. The organization and work of the Committee have been recently and ably described by R. M. Wick in the December, 1947, issue of The Monthly Review of the American Electroplaters' Society. The past and expected accomplishments of this organization constitute a good illustration of the organization of modern research for the benefit of a large group. The plans of the group which struggled in 1924 to set up a continuing constructive research schedule seem to be working out, and the industry can reasonably hope for increasing practical benefits from it.

The Electrodeposition Division of the Electrochemical Society, and Committee B-8 on Electrodeposited Metallic Coatings of the American Society for Testing Materials are also doing constructive work on plating. The book *Modern Electroplating* of the Electrochemical Society and the specifications and recommended practices of the A. S. T. M. and the A. E. S. are concrete published evidence of their aid to platers. The discussions and even the arguments which are engendered by the several different viewpoints so presented can be expected to react favorably on the platers' future work. A recent revision of Blum and Hogaboom's widely used book on plating is now available. These society and publication activities are real contributions to the health of the industry, and are a strong sign of continuing progress.

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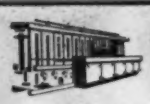
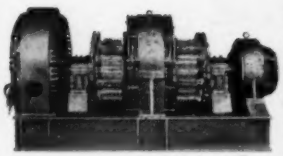


FULL AUTOMATIC CONVEYORS



To insure trouble-free commutation in low-voltage generators you should look for such construction features as fully insulated brush holders and rigging . . . copper pig-tail bar which eliminates current passage thru springs and fingers, and which in turn increases brush life . . . copper graphite brushes to provide optimum commutator efficiency . . . moulded-in "equaload" shunts to distribute brush load equally, reduce resistance. Bulletin No. G-102 describes these and other features inherent in all H-VW-M Low Voltage Generators.

You can be assured of positive current control in tank rheostats by selecting tank rheostats with heavy, knife-type switches . . . plus a master switch which eliminates the necessity for operating several switches each time a tank is unloaded. Also look for generous size special alloy strip resistors which reduce current losses due to overheating and insure long life. These features are all built into H-VW-M Tank Rheostats. Bulletin No. TRA-526 provides complete details.

You can get more "mileage" out of buffs by remembering that buffs cost more than compounds and it's the compound that should do the work. Therefore, be sure and select the right compound . . . one specifically designed for the particular cutting or coloring job so that the compound does the work and not the buff. H-VW-M makes *all* types . . . hand or automatic, bar or liquid . . . fully described in Bulletin No. BC-104

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KW and SK

All subsequent cleaning operations are reduced to a minimum by using K W alkaline cleaner and S K emulsion type cleaner together in the pre-soak operation. These two fast acting, efficient and economical cleaners do a real job of removing oils and stubborn soil when used in combination.

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Bureau of Standards has continued to be a leader in studying and publishing new ideas. Its personnel, as natural leaders in making measurements, has made good use of old test methods and has introduced new ones. Without attempting to list their many accomplishments, I may mention as typical the research now nearing completion on the physical properties of electrodeposited nickel. This is the first metal being studied from this angle on A. E. S. Project No. 9. The final data soon to be published will constitute the most comprehensive body of information along these lines available on any electrodeposited metal. The International Nickel Company through W. A. Wesley and his staff has also determined and published many useful physical data, but its work is relatively specialized when compared with the comprehensive job now being done on Research Project No. 9. Nickel producers welcome this activity, which will make available to the plating field a more comprehensive and judicial set of data than any single company could afford to turn out. A partial preview of these figures shows that the physical properties obtainable in electrodeposits should be a source of pride to the plater when they are compared with properties obtained in the production of nickel by other processes.

British work

A. W. Hothersall and R. A. F. Hammond in 1938 described some rather startling results on freedom from porosity obtained by the use of specially prepared basis metal and carefully cleaned solutions. Their paper represents the culmination of considerable work done by Hothersall and collaborators in earlier years to which my references are still incomplete. Their work points in the direction of better coatings, a direction in which we need to move and move rapidly.

Specification Plating

In 1905 W. D. Bancroft of Cornell University, then President of the Electrochemical Society, said, "If a bicycle is left out over night it will rust". This statement was readily accepted, for no one could contradict it at that time. Today the statement would not be true, and many practical and scientific men would be glad to explain why. We have at least advanced far enough so that we no longer expect to obtain durable protection from a metal coating one twenty-fifth as thick as a single paint film or one-tenth as thick as the thinnest vitreous enamel coating. We have found that great effects can be produced by very thin coatings, for instance, one quarter-millionth of an inch of chromium will prevent tarnishing of nickel for a time, but we have also learned that such a coating is only a few atoms thick, coverage is incomplete, and the deposit cannot be expected to have a permanent effect in corrosive atmospheres. Work now in progress in the A. E. S. Research Committee is throwing light on the fundamental structure and properties of thin coatings. The relating of thickness to the required service has been one of the factors resulting in the present broad use of nickel plating. A good deal of our best plating today is done under the control of thickness specifications; in fact, the growth of reliability in nickel and other electroplated coatings must to a great extent be attributed to such specifications. In 1925 and 1927, papers by Blum and Thomas of the National Bureau of Standards showed a relationship between thickness and protective value of nickel plate, and E. M. Baker had previously shown the same tendency in salt-spray tests. Research Publication No. 712 of the National Bureau of Standards presented complete results for nickel on mild steel, and these data are being confirmed on high-carbon steel by contemporary unpublished results of A. S. T. M. Committee B-8.

The first joint specification of the A. E. S. and A. S. T. M. for thickness of coatings on steel was adopted as tentative in 1935. It covered two thicknesses with minimums of 0.0004 inch (10μ) and 0.00075 inch (19μ). In 1940 a heavier grade was added (0.00125 inch or 32μ) and in 1945 still another (0.0020 inch or 51μ). These specifications have more or less the same pattern as those used in the automotive industry. Not only do these changes in themselves represent a constructive development toward more reliable coatings, but during their adoption the open discussions of performance, methods of plating and testing, and costs have had a healthy effect throughout the industry in encouraging the production of coatings free from at least the worst of the defects which had in the past been thought inherent in nickel coatings.

Specification plating, however, has been widely adopted only in the automotive industry, and as a result this industry has found plating of the greatest use. It is surprising that other industries have not yet seen the light, but attempts are being made to bring others up-to-date. Although we can hardly expect any other group to equal the automotive industry, the use of specifications seems bound to spread, and with it must come an increase in good plating.

Automotive use and design

I must mention this subject, but again I would be presumptuous to try to tell the readers of PLATING about the plating of automotive parts. Nickel producers and the distributors of nickel-plating supplies are attempting to classify the end uses of nickel. Reliable figures are, so far, hard to obtain, but they point to the automotive industry as the consumer of a major but somewhat lower percentage of the plating nickel than was the case before the war. It is positive, however, that this application accounts for more than half the nickel consumed in plating and that it has been a major factor in the recent increase in use. We are told that there is little probability of decrease in this large field under normal conditions. The coatings used until recently were better than they had ever been. They were not yet perfect, and probably

many future plans will depend on how well present cars stand up. Certainly we are learning much from present tests and attempts at improvement. Some success, which is to be hoped for, should mean increased use in this industry and the spreading of the gospel to others.

High current density plating

The Watts bath was first introduced as a "High Speed Bath" and the Phillips low-*p*H solution was a high-speed bath. There has been much recent interest in higher speeds, and higher current densities have been tried and used recently than were visualized in the past. Work in the research laboratory of The International Nickel Company, published in the 1949 *Proceedings* of the American Electroplaters' Society, shows that with the baths and knowledge available today it seems probable that almost any current density might be used which is practical from the standpoint of electrical engineering and power cost. Current densities of well into the thousands of amperes per square foot have been used experimentally.

Building up processes

The use of electrodeposition to build up worn parts was begun during World War I, and was described in 1924 by J. P. McLare. Copper was employed at first in this process, but attention gradually shifted to iron because of its better strength and wear resistance, and later to nickel because of greater ease of plating and the physical reliability of the product. This process has done very well in England, but its adoption in the United States has been very gradual, although it is expected that its many applications probably will be found more useful as greater experience is gained. The major use of this process will probably be as a "putting-on tool" for new parts rather than in repair work.

Many readers have seen the publications from the laboratory of The International Nickel Company and elsewhere on heavy and hard nickel deposits. We believe that the production engineer has at his disposal in these deposits a new method of shaping and building metal parts that can gradually increase his ability to fabricate shapes whose production has formerly been excessively expensive or difficult. Nickel producers recognize and are pleased that the methods which they have themselves described are not the only ones for accomplishing these ends, and they have no desire to push their own formulae or patents which, in the legitimate plating field, are free to all comers. Several new firms are active in this field in an entirely independent manner.

Plating for resistance to chemical corrosion

Closely allied to the build-up process is the plating or cladding of vessels, tubes and apparatus for resistance to chemical corrosion and for the handling of chemicals and food materials which must be kept free from contamination. Rolled nickel and nickel alloys have long been used in this way, and experience indicates that there is a further opportunity in the use of plated nickel coatings where the solid rolled product is less practical because of size, shape, or cost.

Electroforming

Electroforming is a process which has intrigued the plater from the very beginning, and it is surprising that so many electroforming methods have been tried, often operated for a time successfully, and then for reasons unknown to the general public replaced by other methods of fabrication. It is my belief that this process offers considerable promise for the future, but in order to be successful it cannot be developed, as has been so often the situation in the past, in a dark and secret garret out of contact with the rest of the world. Electroformers are not likely to enjoy much success until they are willing to come out in the open and compete with at least as much frankness as other fabricating trades.

Conclusion

K. G. Soderberg has suggested a summary of modern trends which comprises the following items:

1. Reduction of polishing and buffing labor;
2. Better protection at lower cost;
3. More uniform metal distribution;
4. Consolidation of experience into specifications;
5. Publication and discussion replacing old-fashioned secrecy;
6. Mechanically sound deposits for building-up and electroforming.

Such a summary provides much food for thought and could be developed in a more scientific vein than has been done in this present contribution.

Nickel miners and refiners have been rapidly increasing their interest in nickel plating as a market for nickel. It can be seen that their interests are the same as those of the American Electroplaters' Society, i. e., more and better plating. Sales and development staffs have been increased, and laboratories are being built and equipped especially for plating research and pilot-plant work which will bring this branch of the nickel business into its proper place. It can be expected that these laboratories will enable the nickel producer to do more to help the plating industry in the future than in the past.

A rough estimate of the value of the nickel plating business in the United States and Canada is about $100,000,000 per year. There seems to be little reason why it cannot be increased appreciably if the standards of practice continue to improve and the possibilities for new and useful fields of application are exploited.

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Washington Orders

In the beginning of January the material situation as it appeared in Washington was very much like that in 1941 just before World War II broke out. The initiative was in the hands of the enemy or potential enemy, no overall strategic planning was in evidence, and there was no programming of material requirements for defense production.

Material shortages, however, were being met by the Government through limitation and conservation orders issued by the National Production Authority, Washington 25, D. C.

The following is an attempt to review briefly the regulations and orders which directly affect the plater.

Inventory Control.—The first step taken by NPA, on September 18, 1950, was to limit inventories to discourage hoarding.

Regulation 1, of that date, requires that inventories of such materials as caustic soda, soda ash, tin plate, terne plate, galvanized sheet and strip, cobalt, copper, nickel, tin, zinc, and nonferrous scrap in general be kept at a "practicable minimum working inventory" level, i. e., "the smallest quantity of material from which a person can reasonably meet his deliveries or supply his services on the basis of his currently scheduled method and rate of operation". The mechanism for accomplishing this purpose consists in limitations on ordering, delivery and receipts of the material. Certain interpretations, 1, 2, and 3, to Regulation 1 were issued on November 10, 1950.

Additional inventory limitations are found in subsequently issued orders and are set forth below.

Priorities.—Regulation 2, as amended on November 16, 1950, is intended to help a producer of defense equipment or components to obtain deliveries of needed materials. Each purchase order or contract for such equipment is assigned a Defense Order (DO) rating, and this rating can be extended to cover necessary components and materials. A rated order must be given preference to any unrated order, and hence there is no assurance that permitted quantities of a material will be available for civilian use.

As yet there are no grades of DO ratings; all have equal preferential status. In case of conflict, DO orders first received normally have the preference.

Tin.—Under any circumstances, imports of tin into the U. S. A. are expected to be less in 1951 than in 1950 when certain foreign stocks were released. In addition, increased concern is being felt about Far East sources of tin, representing over 60 per cent of the tin supplies.

The first step by NPA, taken on November 14 with the issuance of order M-8, was to limit inventories of tin and to require reporting of usage.

On December 19 this order was amended so that in February and March materials containing 1.5 per cent tin or more may be used for civilian purposes only to the extent of 80 per cent of the rate of use during the first six months of 1950, and this percentage is expected to be reduced in later months. Inventories of pig tin are limited to 60-day supply (120 days for tin plate manufacture). Secondary tin must be used wherever possible in preference to pig tin.

An additional order is in preparation prohibiting certain nonessential uses of tin. In general, this order will cover, it is said, about the same ground as M-43 of World War II fame.

Lead.—At present there is no shortage of lead, and no orders are being contemplated. The shortage which developed during the latter part of World War II was caused largely because of manpower shortages in mines and smelters.

Zinc.—Stocks in the hands of producers have been seriously reduced during the past year. A considerable portion of the zinc ore smelted in the U. S. is mined in foreign countries, especially Mexico. Although there is no world-wide ore shortage, competition for the ore is strong, and U. S. smelters are having difficulties in procuring their requirements. As a result the supply of zinc is tight, especially that of Special High Grade, which is mostly used by platers. Prime Western, used by hot galvanizers, is the next shortest grade.

Order M-15, dated December 1, 1950, attacks the shortage of zinc, by reducing quarterly nondefense uses, beginning January 1, 1951, to 80 per cent of the average quarterly use during the first six months of 1950. This use during any month must not exceed 40 per cent of the quarterly use. An important exception is in electroplating, in that where zinc replaces cadmium no limit is set on its use. Exception is also made for the user of less than 3000 pounds per quarter.

In addition, the order requires that inventories of users be no larger than the amount required for the next 45 days of operation or than a "practical minimum working inventory" as defined in NPA Regulation 1, whichever is the smallest.

There are no end-use restrictions.

Cadmium.—As usual, cadmium is in very tight supply. The annual production, about 8,000,000 pounds, is about the same as that reached during World War II, but industrial activity is greater. Some additional cadmium may be produced if zinc production can be raised, and some additional recovery units may be installed, but no large increase in production can be foreseen.

Order M-19, dated December 27, 1950, like World War II order M-65, is a permissive order, i. e., cadmium may be used for only those purposes which are expressly permitted in the order. These are substantially the same as those found in the World War II order, and the plater will find listed those essential purposes for which there are no suitable substitutes.

Unlike other orders, M-19 makes no difference between DO-rated and unrated purchase orders, i. e., even priority orders are subject to the requirements set forth in M-19.

Inventories are restricted to 30-day needs.

There is no allocation of cadmium, but all purchase orders must carry a signed certification to the effect that the cadmium items and products will be used only for purposes permitted by the order.

Nickel.—The present nickel order M-14, issued December 1, 1950, is very similar to the zinc order. It limits the quarterly use of nickel for nondefense applications to 65 per cent of the average quarterly use during the first six months of 1950 and the monthly use to 40 per cent of the permitted quarterly use. An exception is made for a person who uses less than 250 pounds during a calendar quarter; he may use up to 250 pounds during such period.

For maintenance or repair, nickel may be used in an amount not exceeding the average quarterly consumption during the first half of 1950.

Inventories must be a "practicable minimum working inventory" as defined in Regulation 1 or the amount needed for 30-day operation under M-14, whichever is less.

By nickel is meant primary nickel in the form of electrolytic nickel, ingots, pigs, rolled or cast anodes, oxides and residues derived directly from new nickel and apparently not nickel chemicals ordinarily produced as by-products.

(*Continued on page 166*)

project no. 12

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*AUTHORS

Cleaning and Preparation of Metals for Electroplating

I. CRITICAL REVIEW OF THE LITERATURE

(*Continued from the January issue*)

4. STANDARDS OF CLEANLINESS
   - A. Introduction
   - B. Nature of Adhesion
   - C. Origin and Effect of Films
   - D. The Effect of Surface Condition of the Metal on Degreasing
   - E. Summary

A. Introduction

Before it is possible to evaluate the cleanliness of metallic surfaces, it is necessary to agree on a definition of cleanliness. "Clean" means different things to different people. In this report, only the requirements for cleanliness of surfaces being prepared for electroplating will be considered.

The ultimate test for the cleanliness of the surface is the quality of the electrodeposit. If the surface accepts an adherent and continuous deposit, it has been satisfactorily prepared. We must now consider what properties such a surface must possess. E. H. Lyons, in a paper entitled "What is a 'Clean' Surface?[107]" states that only rarely, if ever, does a metal article to be plated enter the electroplating bath with a truly clean surface. Various types of films are present on the surface. What is required is a surface which will receive a smooth, adherent deposit. In short, an acceptable surface is one on which "objectionable surface films have been replaced by films more suitable and acceptable for electroplating"[107].

In discussing adhesion or nonadhesion of deposits, it must be borne in mind that failure of the deposit may be due to two different causes: (a) failure of the bond between basis metal and deposited metal and (b) structural failure of the basis or deposited metal itself. In short, we might refer to nonadhesion and noncohesion of plated objects[50,59,83,84,98,100,106,107].

B. Nature of Adhesion

Before the origin and effects of various films on metal surfaces are examined, it might be well to consider briefly the nature of adhesion. Much of this discussion is taken from the series of papers entitled "Adhesion of Electrodeposits", published by A. E. S. Research Project No. 3, which was directed by Dr. A. L. Ferguson[3].

Molecules are composed of atoms held together by so-called chemical, van der Waals, electrovalent, or covalent forces or a combination of such forces. Because all matter is made up of atoms combined into molecules, it is difficult to account for the existence of any forces basically different from those found in the ultimate building blocks of all molecules, namely, the electrical and magnetic forces in the atom. This point of view, that the forces involved in adhesion are identical with those involved in cohesion, adsorption, chemical reaction, and crystallization, i. e., that they are all atomic in nature, is supported by much experimental evidence. For example, the heats of adsorption are of the order of magnitude of 20–100 kcal/mol, so that the

bonds formed between the metal and the adsorbed gas are about as strong as those existing in stable stoichiometric compounds. There are even instances known in which the strength of the force between the adsorbed material and the metal is greater than the cohesive force, or tensile strength, of the metal itself (e. g., oxygen adsorbed on wolfram).

The strength of a force increases with decrease in the distance over which it operates. The rate at which the strength increases with decreasing distance becomes much greater the shorter the distance, reaching a value of a high order of magnitude at interatomic distances, and being practically zero when the distance is equal to a few molecular diameters[121]. This means that the greatest manifestation of force strength is within the atom. Next in magnitude would be forces between the atoms within the molecule (atomic, valence, or chemical forces). Next would be forces between molecules or atoms of the same composition (molecular, or cohesive forces) and between molecules of different kinds (adhesive forces). According to the modern concept of the structure of metals, only atoms are present. This means that all the forces, including those at the surface which result in adhesion, are atomic in nature.

The strongest possible bond between deposited and basis metal should be one in which the atoms of the electrodeposited metal continue the crystals in the surface of the basis metal[2,3]. The phenomenon of continuation is at times observed in photomicrographs of electrodeposits[99]. Under certain plating conditions the orientation of the deposited metal is identical with that of the basis metal[35,170,196], and individual grains in the deposit may grow as continuations of grains of the basis metal[18,58,81,86,99,174]. In addition to requiring cleanliness, such bonding calls for low current density in the plating bath and absence of electrophoresis of colloid material. It has been said that the crystal structure of basis and depositing metal must be similar for this type of bonding to occur[81], but exceptions to this statment are now recognized[82].

Incompletely cleaned basis metals can exhibit such bonding[162], either because of cleaning action of the plating bath or because of discontinuities of the film present, permitting "bridging-over" of deposits. The forces involved in such bonds do not extend far from the surface of the metal, and the bulk of the deposited metal will usually adopt its own characteristic crystal structure[16,20,57,190]. Another type of bond which should be of atomic nature is involved in the formation of a metallic compound or alloy between deposited and basis metals. Examples of metals that alloy at room temperature are cadmium from cyanide baths on brass and zinc on platinum[12,177].

Another theory which has been proposed to explain the adhesion of deposits is that it is of a mechanical nature[45,146]. This mechanical adhesion is due to "hooking" or interlocking of the basis metal and deposit. This explanation has been advanced especially in connection with the adhesion of deposits to aluminum. In this case it is usually necessary to secure roughening of the basis metal before any noteworthy adhesion is obtained[140,177]. Interlocking may be necessary to secure good adhesion where the surface is covered with a passive oxide layer[3], but it hardly seems as if any very high degree of adhesion could be obtained by mere interlocking. It would appear more reasonable to assume that the roughening of the surface makes it cleaner and "opens-out" the surface so that it has a much larger area. The forces of adhesion can thus come into play better and can function over a larger area and have a much higher total value[45]. In general, the most highly polished surfaces can take a perfectly adherent plate[119]; in fact, adhesion, except in the case of aluminum, is usually improved by the use of polished surfaces[118].

C. Origin and Effect of Films

The films present on the surface of metals being plated may be classified as follows[107]:

1. Substances not chemically associated with the plating metal or with the basis metal itself: oils, waxes, soaps, pickling inhibitors, drawing compounds, buffing and polishing compounds, and dirt picked up in handling.

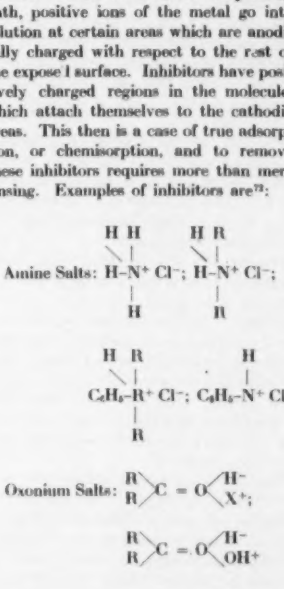
2. Substances derived from the basis metal: corrosion products, e. g., oxides, carbonates, and sulfides; cleaning bath residues, e. g., sulfates, chlorides, phosphates, etc.; and pickle smut, consisting of finely divided grains of the metal itself, as well as of undissolved impurities and constituents such as carbides.

3. Substances composed of altered basis-metal surface layers. The surface of the basis metal itself may be physically unsound because it consists of a film of stressed, distorted, broken, or disordered metal resulting from grinding, polishing, rolling, drawing, or other finishing processes.

These three classifications will now be considered separately.

The presence of *films of the first type* will obviously prevent adhesion of deposits. The oils, waxes, polishing compounds, and dirts should be removed in the main cleaning bath. Blum and Rawdon[15], in studying the influence of the basis metal on the structure of the electrodeposit, found that acid-copper plate on copper continued the structure of the basis metal. The plate actually formed an integral part of the basis metal. On the other hand, if thin layers of grease were present, the distance between atoms of the basis metal and of the deposit was lengthened, and adhesion was poor. Light oil films can be displaced during plating when the plating bath is warm and highly alkaline[107]. Thus, cadmium plating can be achieved without any cleaning whatsoever. Although a thick film of emulsified oil and deflocculated dirt covers the surface of the bath, the plate adheres satisfactorily[107]. The presence of very thin layers of hydrocarbons on metal surfaces has been detected by means of electron diffraction pattern studies[91].

Particularly troublesome are adsorbed soap and pickling-inhibitor films[72]. Soaps and synthetic detergents are surface active and can form adsorbed films of organic materials on the surface. Pickling inhibitors permit attack of oxide but protect the metal surface. Their action is associated with adsorption on the metal surface. When work enters the pickling bath, positive ions of the metal go into solution at certain areas which are anodically charged with respect to the rest of the exposed surface. Inhibitors have positively charged regions in the molecule, which attach themselves to the cathodic areas. This then is a case of true adsorption, or chemisorption, and to remove these inhibitors requires more than mere rinsing. Examples of inhibitors are[72]:



In bright-plating baths, the surface of the metal is said to be coated with an adsorbed organic film before deposition commences. This is a step in the bright-metal deposition and ordinarily does not interfere with adhesion[72]. However, many otherwise good organic brightening agents cannot be used because of their adverse effect on adhesion of electrodeposits.

Films of substances derived from the basis metal are more prevalent and cause more trouble in plating than do films of the other groups[72]. Oxide is the most common metal-derived film, because most metals form oxide films almost immediately on contact with air. Oxide films can be formed even under inert liquids. For

TABLE VIII. THICKNESS OF FILMS[69]

Oxide Films on Iron		Stationary Films on Smooth Metal Surfaces	
Straw	460 Å	Mercury in dry air	15–20 Å
Reddish-brown	520	Aluminum in dry air	100–150
Red-Brown	580	Iron in dry air	15–25
Purple	630	Austenitic stainless in dry air	10–20
Violet	680	Iron and steel treated anodically in sulfuric acid	40
Blue	720	Iron treated anodically in neutral sulfate solution	60–80

example, abrasion of copper under benzene produces thicker oxide films (due to the temperature increase in the abrasion process) than those normally found on mere exposure to air[27]. The thickness of invisible oxide films on iron and the thickness of stationary films on smooth metal surfaces are given in Table VIII.

In connection with this table, it should be remembered that atomic forces of attraction are very small at distances of 30 Å* or more.

The rate of formation of oxide layers on various metals and the structure of such layers have been thoroughly studied by E. A. Gulbransen and co-workers, using electron diffraction and vacuum microbalance techniques[62–68].

The porosity of oxide films varies tremendously, from metal to metal as well as with the same metal, depending on the treatment. Air-formed oxide on iron is one thousand times as porous as that on aluminum, and the hydrated oxide film often produced on wet iron surfaces is still more porous. Induced oxide films on aluminum are hard and resistant to abrasion, but those on other metals may be quite easily ruptured[72].

Passivity is sometimes attributable to protective oxide films. The theory of formation of passive (protective oxide) films on metals has been discussed in the literature, for example by Mott[125], and it will not be discussed here. Nonelectrolytic and electrolytic alkaline cleaners leave passive surfaces or oxide coated surfaces or both on most metals, especially in anodic cleaning. However, even cathodic cleaning may leave behind oxide films. Smith and Karle[142], using electron diffraction patterns, investigated steel cleaned cathodically in caustic and phosphate solutions and found δ-Fe_2O_3 on the surface when steel anodes were used. The oxide was supposed to form at the anode, become colloidally dispersed, and be deposited electrophoretically at the cathode. With silicate solutions, films of Greenalite ($9FeO \cdot Fe_2O_3 \cdot 8SiO_2 \cdot 8H_2O$) were formed on the surface. These oxide films can be, and are, removed by an acid dip, but even if the wet surface is kept acidic, oxide films are usually found again on the surface by the time plating begins[107].

There is little doubt that such oxides ordinarily prevent adhering deposits from forming. There appears to be some confusion in the literature on the subject of plating on passive surfaces. Lyons[107] states that, although passive surfaces generally interfere with adhesion of deposits, some common plating processes deposit metal directly on a passive surface. Part of this confusion may spring from the fact that passivity may arise out of a variety of causes. Where the passivity is due to a protective oxide layer, the surface probably cannot take a successful plate[99]. However, anodized aluminum may be plated, indicating that the depositing metal may sometimes satisfy the available metal surface forces more effectively than oxide and thus displace it[3]. The plating baths themselves may have a definite cleaning action, being able to remove light oxide films. Both acid and cyanide baths may possess such action[107]. In addition it has been noted that acid zinc or nickel plating takes place at times through a light, compact film of ferrous oxide on a steel surface, leaving the film intact but raised from the original surface. Thus an adherent plate forms under the film. After plating, the film may be wiped off[107].

The oxidation of freshly cleaned and pickled steel affects plating in the following manner[107]: As the film forms on the wet surface, it goes through a number of stages. At first, it is invisible and does not interfere with adhesion. In the course of a minute or two, it thickens enough to become visible and at some point begins to interfere slightly with adhesion of the electrodeposit, probably being partly displaced and partly penetrated to some extent. As the film begins to dry, it becomes less subject to penetration and causes peeling of the subsequent plate. Finally, when the surface is in a more advanced stage of rusting, the film conducts no current, and deposition is, at best, spotty.

Corrosion on exposure to air may, in addition to oxides, cause the formation of carbonate and sulfide layers. The usual alkaline cleaning baths may also leave behind insoluble layers of sulfate, chloride, arsenate, silicate, phosphate, and nitride. Sometimes these films are desirable to protect the metal surface from oxidation during handling. Examples are Bonderizing or Parkerizing of steel, silicate treatment of aluminum, and various other phosphate and chromate processes. These films must be removed by an acid dip before plating, but in some cases this is not absolutely necessary. For example, Bonderized steel may be plated, although there is some doubt here as to whether the phosphate coating is dissolved or displaced before electrodeposition or remains under the plate[104,107].

Finally to be considered in this class are those impurities arising from pickle smut. These films usually consist of finely divided grains of the metal itself, as well as of carbides, carbon, or silica. If not removed, these materials may result in surface blemishes upon later processing. In addition, the acid dip may leave behind acid salts of the metal, which may cause spotty surface corrosion, leading to subsequent blisters in the plate[72]. However, adhering plates can on occasion be obtained on surfaces lightly covered with pickle smut[107].

Poor plates may result from the presence of a *"skin" of highly stressed, worked metal on the surface*. Such a film of stressed, distorted, broken, or disordered basis metal may result from grinding, polishing, rolling, drawing, etc.[3,72,107]. Drawing operations may result in striations due to imperfections in the die or to inclusions of abrasive particles. Deformation at low temperature results in crystals gliding over one another along slip planes and grain boundaries so that disorganized matter is produced. Subsequent annealing may result in new crystal growth from nuclei in the disorganized layer, resulting in new crystal boundaries and altered surface characteristics[69,72]. Abrasion produces less flow than buffing or fine polishing operations, but the layer of disorganized material is deeper. In the latter operations, basis metal may actually be flowed over areas of grease and wax, leaving a very disordered surface[86]. For instance, the surface layer of heavily buffed brass must be removed to secure good adhesion of electrodeposits[72]. The structure of polished surfaces has been described in the following manner[122]: There are three layers, each with progressively larger crystals, namely, (a) a buffed or polished layer with the oriented crystals containing 3–100 atoms, (b) a severly cold worked layer of much larger crystals, and (c) a layer of gradual transition to the bulk of the metal. The usual cleaning processes remove the (a) layer.

*1 Å (Ångstrom unit) = 0.000001 cm = 0.0000004 inch.

The usual way of removing such films is to make the piece the anode and allow the worked layer to be oxidized away, exposing sound metal[100]. If these "skins" are not removed, peeling may occur[82,84]. Such surfaces tend also to induce a weak, columnar microstructure in copper deposited on steel or brass, which accordingly splits open under bending stress[100].

Another source of weakening of the basis metal surface is hydrogen embrittlement. When articles, especially of stressed high-carbon steel, are electrocleaned cathodically, hydrogen is adsorbed and causes embrittlement of the metal. Such metal will not usually be plated successfully, owing to cohesive weakness. Worked-metal "skins" have increased susceptibility to hydrogen embrittlement[82]. A heat treatment at low temperature will drive out the hydrogen[86].

D. Effect of Surface Condition of the Metal on Degreasing

Not only does the condition of the metal surface affect the quality of the electrodeposit, but it may also render degreasing easier or more difficult. Unfortunately, little work on this subject has been reported. Spring and his co-workers[135,137] have recently presented some papers on the subject. They found that mineral oil may be removed from cold rolled steel more readily when it is unpickled than when it is pickled. Fatty oil containing free fatty acid behaved oppositely. The ease of cleaning diminishes as the roughness of the surface increases. After a certain level of considerable roughness has been reached, effects due to the oxide film are lost.

An explanation of the foregoing is that the surface oxide satisfies the residual valence forces at the surface and causes adhesion of metal to mineral oil to be weak, so that oil is more readily removed. Removal of oxide by pickling upsets this condition. On the other hand, fatty oil is rich in free fatty acid that could cause soap formation or chemisorption on oxide-covered surfaces. Pickling here would reduce the adhesion of oil to metal by preventing compound formation.

E. Summary

It can be seen from the preceding discussion that the definition of cleanliness is not an easy one to make. About all that can be said now is that a "clean" metal, one which will take a successful plate, need not be completely free of all films, indeed, probably cannot be completely freed of all films. However, any film exceeding about 50 Å in thickness will probably cause trouble. Furthermore, the term cleanliness must be expanded to take in the condition of the top layers of the metal. The problem is further complicated by the action of plating baths in altering the surface condition of the metal.

It will be the purpose of this project to determine the chemical and physical properties which a metallic surface must possess in order to be plated upon successfully, i. e., to develop "standards of cleanliness". It is hoped that it will then be possible to set up convenient tests which will indicate the extent to which a sample meets the requirements of the "standards of cleanliness".

The various methods which may be used to evaluate the condition of metal surfaces will be presented in the next section of the report.

5. METHODS OF EVALUATING CLEANLINESS

- A. Indirect Tests
  1. Analytical methods
  2. Specifications
  3. Colloidal properties
  4. Water softening
  5. Solvent action
  6. Surface tension and interfacial tension measurements
  7. Emulsification
  8. Rinsability
- B. Direct Tests
  1. Evaluation of absence of grease
     - (a) Water-break
     - (b) Spray-pattern
     - (c) Gravimetric
     - (d) Residue-pattern
     - (e) Fluorescent dye
     - (f) Radioactive tracers
     - (g) Ferricyanide paper
     - (h) Copper deposition on iron
  2. Evaluation of total surface cleanliness
     - (a) Examination of electrodeposits
     - (b) Contact resistance
     - (c) Force of detachment
     - (d) Monomolecular films
     - (e) Optical methods

Two general types of tests are employed in evaluating cleaning effectiveness. In the first type, an attempt is made to predict the surface characteristics of the cleaned metal from the physical and chemical characteristics of the cleaning solution. These are considered indirect tests. In the second type, direct tests, the surface of the metal itself is examined to determine the effectiveness of the cleaning. Since this project will be concerned with the latter type of tests, indirect tests will receive but brief mention here.

A. Indirect Tests

The outline followed here is taken from that appearing in an A. S. T. M. publication by Harris[71].

1. *Analytical methods*

Suggested procedures for analyzing typical detergent solutions are contained in an A. S. T. M. publication[5]. Measurements of *p*H may be either colorimetric or potentiometric. Details of such measurements and of titration-curve analyses will be found in the following references: 36, 69, 77, 102, 113, 123. Tests for measuring conductivity of electrolytic degreasers are to be found in the following references: 36, 113.

2. *Specifications*

Specifications for typical detergent solutions will be found in the above cited A. S. T. M. booklet and in the following references: 155, 160.

3. *Colloidal properties*

Evaluation of colloidal dispersion, adsorption, and deflocculation of soils is discussed in the following references: 36, 38, 43, 60, 102, 108.

4. *Water softening*

Tests are available for determining the water-softening properties of detergents, but unfortunately these tests are generally inapplicable in the presence of synthetic detergents. Consult the following references: 52e, 52g, 52m, 102.

5. *Solvent action*

Where the degreasing power of a solution is dependent upon its solvent capacity, as in the case of the chlorinated hydrocarbons, the following references to solvent action are of interest: 14, 21, 42, 43, 52b, 52c, 52f, 52j, 52k, 52l, 52o, 52q, 52t, 55, 61, 68, 87, 89, 126, 132, 146, 152, 154, 162.

6. *Surface tension and interfacial tension measurements*

Detergent action is at a maximum when surface and interfacial tensions are at optimum values[14,38,43,123]. Surface tension may be measured by stalagmometer dropping in air or, preferably, by use of the du Nouy tensiometer with proper precautions. Interfacial tension measurements may be made with a stalagmometer dropping through the solution or with a modified du Nouy apparatus. Details of the various methods for determining these values will be found in the following references: 7, 38, 52a, 52i, 52m, 52n, 52p, 52r, 52s, 93, 156.

7. *Emulsification*

Tests for emulsifying action and for degree of stability of emulsions will be found in the following references: 14, 36, 38, 43, 52f, 52o, 52q, 52t, 108, 117, 123.

8. *Rinsability*

It is very important that the detergent rinse away easily, and for this reason a number of specifications stipulate particular rinsing tests: 52d, 52g, 52h, 52i, 52k, 52l, 52p, 52r.

B. Direct Tests

The methods to be considered here fall into two classifications: (1) those tests which determine only the degree of absence of grease and (2) those tests which

determine not only the degree of absence of grease but also the degree of absence of inorganic contaminants, in short, those which determine the degree of chemical cleanliness of the surface.

1. *Evaluation of absence of grease*

a. *Water-break.*—The water-break test would appear to be the most widely used method in shop practice today[71,111,113,133]. Hence any research program in metal cleaning must take cognizance of this method. It is based on the ability of a metal surface when supposedly clean to sustain an unbroken film of water. Objection to this test has been made on the grounds that preferential adsorption of material presenting a hydrophilic surface could cause a dirty surface to sustain a water film. This can be avoided[111] by adding a 3–5 per cent (by weight) H_2SO_4 dip and a water rinse following the original water rinse, a procedure which is felt to be necessary especially when wetting agents are used in the cleaner. Another drawback is that the pattern obtained is a function of the thickness of the water film[105]. Smaller and smaller areas sustaining a complete water film are obtained as the water drains from the panel. As these areas begin to reach a more or less constant size, evaporation of the water becomes a factor in obscuring the results. It might be possible, however, in conjunction with other cleaning tests, to produce a cleaning index based on area covered by water-break *vs* time. Such changes in water-break pattern with time are especially easy to observe on rolled aluminum and its alloys[112]. Objects which show no break in a cold rinse will sometimes do so in a hot rinse. Thin films of oxides, tarnish, cleaner residues, etc., will not cause water-break. Indeed, it has been suggested that thin films are required to give a surface free from water-break[71].

b. *Spray-pattern.*—This method was designed by Spring and co-workers[108]. Since it is basically a modification of the water-break test, many of the comments made above apply here. However, this test makes possible a numerical evaluation of cleaning efficiency, and it is claimed that the pattern is stable for at least twenty minutes. In this method, a fine spray of water is directed at the panel from a distance of two feet by means of an atomizer connected to a compressed air line. (A small spray gun, such as is used for spraying paint, was also used.) The pattern of water droplets on the panel is observed and is reproduced by eye on cross-section paper ruled into 100 squares. (The authors used square panels in their tests.) The number of squares not covered by droplets is counted, and the figure obtained is the "cleaning index", which may range in value from zero to 100. It should be pointed out that index values obtained by this method are useful primarily for comparing performance ratings of good cleaners. If the cleaner is poor, it is not likely that water-break will be absent anywhere on the panel surface. Hence, the index value would be zero for such cleaners. In short, the spray-pattern test will give numerical evaluation where the water-break test shows absence of water-break somewhere on the panel surface, but will tell nothing more than the water-break test when there is complete water-break.

It is felt that Spring's method of reproducing the pattern is somewhat inadequate in that it is subject to subjective errors. Photographic analysis is not suitable owing to lack of sufficient visual contrast. One suggestion would be to use a contrasting dye in the water, making such photographic reproduction possible. Still another way would be to use a pantograph which would trace the pattern on a piece of paper while the operator went over the panel surface with a stylus.

c. *Gravimetric.*—Two general procedures are available for determining residual soil gravimetrically. In one method[111] the panel is washed with 100 ml of petroleum ether. The ether is carefully collected in a tared evaporating dish and evaporated on a steam bath. The dish is then heated in an oven for 15 minutes at 100° C (212° F), cooled, and weighed. This result is compared with a blank run, in which the evaporating dish is cleaned and dried at 100° C, cooled, and weighed to insure correct original weight. In another method[109,111], the panel is weighed, washed with benzene, rinsed in ethyl alcohol, dried with paper towelling, and reweighed.

Neither of these methods is sensitive enough for the evaluation of good cleaners, and for poor cleaners the results reported in the literature show poor reproducibility. Gravimetric methods also yield no information about the distribution of the soil on the surface. On the other hand, the methods are rapid and require no special equipment. The main value of such tests is that they supply information which can be used in correlation of weight of residue with visual appearance as determined by other tests for evaluation of degree of grease removal. Of the two gravimetric methods, the first is considered to be the better.

d. *Residue-pattern.*—It has been observed[111] that when panels are removed from the oven preparatory to weighing in the gravimetric test, stained residue-patterns are visible. The area covered by such patterns is measured to obtain a cleaning index similar to Spring's. Such values were found to correlate well with the subsequent gravimetric test. It is felt that this test has but limited value, as scale, oxide, etc., will obscure the results. However, in view of the results reported in the literature, it is probably wise to give consideration to this method, especially in connection with the spray-pattern test.

e. *Fluorescent dye.*—Morgan and Lankler[128] have introduced a new test based upon the fact that mineral oil fluoresces brightly in ultraviolet light. Other oils which do not fluoresce in their own right can be made to do so by the addition of an oil-soluble fluorescent dyestuff. In as much as fluorescence of an oil is proportional to the amount of oil adhering to the metal surface and clean metal appears black under ultraviolet light, a natural scale of measurement is established for evaluating cleaning efficiency. Gravimetric tests indicated a lower limit of sensitivity for this method of about 4×10^{-6} g/cm^2.

The test is quite sensitive and is ideally suited for testing a series of samples in which one factor, say percentage of wetting agent, is varied in a given cleaner. However, for isolated tests, the method is qualitative only, because absolute brightness of the plate is not determined. Also, it is questionable whether the test will indicate the amount of oil present or merely its surface distribution. It is felt that two panels, each with the same weight of oil, one with an even surface distribution, the other with the oil concentrated in a few globules, would show different values of total brightness. It might prove interesting to compare the surface distribution in this test with that in the spray-pattern test. Another objection to this test is that the cleaner used may not remove dye and soil in the same proportion as originally present.

f. *Radioactive tracers.*—This newest of evaluation techniques is described by Harris, *et al.*[73]. The tracer used is N, N di-n-butyl stearamide ($C_{17}H_{35}C^{14}ON(C_4H_9)_2$), synthesized from di-butyl amine, stearic acid and $C^{14}O_2$ (half-life 5,300 years). This tracer is added to the soil to the extent of about 1 per cent by weight. About 25 mg of soil is applied to the circular, 1-inch (25-mm) diameter, test piece with a glass rod. A background count is made with a Geiger-Muller counter prior to soil application. Perfect cleaning is evidenced by a Geiger count equal to the original background count. It was found that three or four washings after soil removal were necessary to achieve such a result. It was shown that this effect was due to chemisorption of the tracer on the metal. The equipment required is described.

The method has been criticized on the basis that the tracer segregates on standing and that preferential adsorption of the tracer takes place. In addition, the size of the panel is limited by the opening of the Geiger counter, thus making it difficult to apply such standard tests as water-break, fluorescent dye, etc. Also, Harris used this test only as a "null-point" test, i. e., the cleaner was either 100 per cent effective, or it was not. In

order to extend this test to provide a measure of cleaning efficiency it would be necessary to make a true initial count and apply various corrections[167].

g. *Ferricyanide paper.*—This test was first introduced by Walker[102] and has been modified by Macnaughtan[110]. The reagent is prepared by simple immersion of suitable paper in the following solution: 60 g NaCl; 10 g $K_3Fe(CN)_6$; 10 g $K_4Fe(CN)_6.3H_2O$; 1 liter of water. Ferrocyanide is added to make the mixture suitable for the testing of copper specimens, as well as iron specimens. The test panel is dampened, and a sheet of the reagent paper is placed on the surface and gently smoothed out. The sheet is allowed to remain a few minutes and is then removed, washed, and dried. Color changes will indicate formation of iron and copper complexes. Improperly cleaned areas should not be affected. Laboratory trials will be necessary to determine the effect of scale, oxide, etc., on this test. By measurement of areas, a cleaning index can be obtained[113]. The tendency of such a test to cause pinholes may be reduced by the use of the "two-stage" print method[17,84,97,171-173].

h. *Copper deposition on iron.*—In this test, the ferrous sample is immersed into a simple copper salt solution, such as a 5 per cent (by weight) sulfate solution[173] or a solution of 5 per cent (by weight) copper sulfate and 5 per cent (by weight) sulfuric acid[79,111,113]. Galvanic replacement takes place, with copper replacing iron on all clean surfaces. A quantitative comparison of cleaners has been made by determining the time required to clean panels as indicated by this method. One way of determining the amount of surface plated with copper would be to use the ferricyanide paper test mentioned above. One drawback to this test is that the test solution is bound to exert some cleaning action on oxide- or smut-covered parts without affecting greasy spots. Thus, a failure in the copper plating test would indicate that degreasing was incomplete; success of the test would not necessarily mean that the sample would have plated well, as there might be oxides and smut present which were removed during the course of the test.

In the section of the report dealing with cleaning methods, alkaline copper cyanide cleaning was discussed. This bath could be converted into an evaluation test by using low current densities so that the copper would plate out gradually. Thus, it should be possible to obtain a plot of cleaning *vs* time. In order to insure that no plating will occur on uncleaned spots, the bath composition will have to be controlled. It should be borne in mind that this is both a cleaning and a plating test, so that this method of evaluating cleanliness of metal surfaces can be used only for the alkaline copper cyanide cleaning bath. It cannot be used to evaluate the cleanliness of metals cleaned in other fashions, since it would not be possible to distinguish between the cleaning done in the cleaning bath and that done in the testing bath.

2. *Evaluation of total surface cleanliness*

a. *Examination of electrodeposits.*—Because it is the purpose of the metal cleaning discussed in this report to prepare surfaces for electroplating, it follows that the examination of electrodeposits is indispensable in setting up "standards of cleanliness". Four important criteria to be examined here include adhesion of deposits, gross porosity of deposits, corrosion resistance of plated metals, and microstructure of the deposit and basis metal.

Adhesion: The American Electroplaters' Society has had a research program on this subject[2]. In as much as this reference contains an excellent bibliography on this subject, no extensive bibliography on adhesion of electrodeposits need appear here. Summarizing these reports of Dr. Ferguson, it is found that few quantitative tests are now available for testing the adhesion of deposits.

The earliest quantitative test is by Burgess[25], who tested the adhesion of zinc deposited on iron. He soldered a copper plug to the zinc coating and noted on a spring balance the pull necessary to detach the plug. Because the zinc adhered to the plug more strongly than to the iron, a measure was had of the adhesion of zinc to iron. It has been thought that an error might be introduced because the sample must be heated to a sufficiently high temperature to cause the solder to adhere. This has been believed to decrease adhesion; recent studies indicate that heating may improve adhesion in some cases.

The quantitative test principally used today is the Ollard test, first introduced in 1925[126]. In the original method, a steel rod, one inch in diameter and two inches long, was waxed all over except at one end. After pickling, it was hung horizontally in a nickel bath and deposition was made for 250 hours under conditions found to be the most favorable. The specimen was then removed from the bath and placed in a lathe, and all the nickel that had deposited over the edge was turned off, leaving an end of nickel on the rod overhanging by ¼ inch. The bottom of the rod was drilled and tapped to take a threaded ½-inch rod and the specimen put through a 1-inch hole drilled in a steel plate. The plate was then placed across the top of a tensile machine and the ½-inch rod gripped in the lower jaws of the machine. In this way, the deposit could be pulled off the steel. In a second test, a ½-inch hole was drilled down the middle of the nickel deposit into the steel. Then, a steel rod was placed through the hole onto the steel and the steel pushed off the nickel deposit.

Various modifications of this method have appeared through the years, such as those by Faris, Hothersall, Leadbeater, and Roehl. The Roehl modification[160] ensures that the break occurs more nearly by tensile separation. In this method, 0.01 inch of the under side of the nickel deposit is machined off so that the interface nickel-steel is below the shoulder of the specimen. In a manner analogous to the second version of the Ollard test, a hole, ¾ inch in diameter and 3/8-inch in depth, is drilled through the nickel into the steel. The test piece goes into a die and a load is applied by means of a rod in a tensile machine until the nickel ring is forced off.

A wide variety of qualitative adhesion tests are reported by Ferguson, among them: bending and twisting tests; burnishing, buffing, and abrasion tests; impact or hammering tests; heating tests; fluorescent test; Erichsen cup test; scratch tests; chisel tests; "can opener" tests; Jacquet test. The reader is referred to the Ferguson papers for details on these qualitative tests.

Gross porosity: The gross porosity of electrodeposits may be conveniently measured by the potassium ferricyanide paper test mentioned above. This test presupposes that improperly cleaned areas of the metal surface will not plate well, leaving bare spots on the surface.

Corrosion: The corrosion resistance of plated metals is often evaluated in a salt-spray cabinet. Again, metals which have been improperly cleaned will not plate satisfactorily and leave bare areas where corrosion will readily take place.

Photomicrographs of deposits: When metals of crystal structure similar to that of the basis metal are electrodeposited there is a tendency for the first portion of the deposits to continue the crystal patterns of the basis metals provided the interface is clean[3]. In fact, this will occur at times even when the crystal systems are different. Hence photomicrographs of cross sections might well form the basis for a cleaning test. When such a test is used, it should be kept in mind that wherens continued crystal growth into the depositing metal is unlikely if the atomic forces of adhesion are weakened by the presence of very thin films, the plating bath will often have sufficient cleaning action to remove such films and permit intimate contact. Another factor is the tendency of the depositing metal to replace surface films. Thus, evidence of continuous crystal growth does not necessarily imply absolute chemical cleanliness of the metal entering the bath. This is especially true in the cyanide plating baths.

b. *Contact resistance.*—Measurements of contact resistance between metal surfaces is common as a factory production check of the preparation of Alclad 24S-T surfaces prior to spot welding[78,159,161]. It

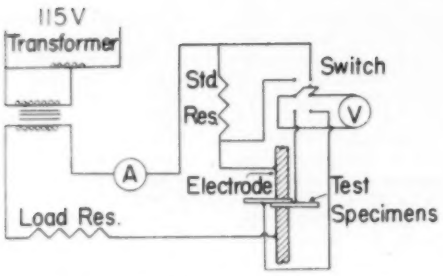


Fig. 3. Measurement of contact resistance[155]

ought to be possible to extend this test into a general one for evaluating metal cleaners.

Fig. 3 shows a typical diagram for measuring contact resistance. The contact resistance is a function of the pressure applied by the press. Pressures in the range of 400–1000 psi are satisfactory, all tests being conducted at any chosen value in this range.

Because of the nonuniformity of surface films of grease, oxide, etc., and the action of the applied pressure in changing the surface characteristics[153], the determination of a representative contact resistance is essentially a statistical problem.

c. *Gwathmey (force-of-detachment) test.*—This force-of-detachment test measures the force required to pull apart two crystals of a metal that have been placed in intimate contact[68]. Because contact with air destroys the force of contact by interposing an oxide layer, all the tests were done in a hydrogen atmosphere. The force of detachment divided by the area of contact was found to be of the same order of magnitude as the tensile strength of the metal. This is a highly sensitive test, and there is no doubt that such a test will provide a criterion of cleanliness which is far more severe than that required for plating. However, such a test provides a good basis for comparison with the other tests cited.

d. *Monomolecular film.*—Probably the best manner in which to correlate metal-surface cleanliness with quality of electrodeposits is to soil a surface devoid of foreign contaminants to a quantitatively known degree and then plate it. The best way to accomplish this is to utilize the Langmuir technique[13,39,39,90,157]. In this procedure, a small percentage of a fatty acid or fatty oil is dissolved in benzene, and a minute amount of this solution is placed on a cleaned water surface. (The water is cleaned by skimming the surface with a piece of paper.) The amount of oil placed on the surface is such that a monomolecular layer of the fatty material will not cover the total surface area upon evaporation of the solvent. In the case of triolein, the monomolecular film so formed is 1.1×10^{-7} cm thick. Such films can be transferred to a glass or metal surface by raising the surface slowly out of the water on which the film is spread. For glass surfaces, the water should be slightly alkaline, for metal surfaces, slightly acid. A constant surface pressure is maintained on the film as the process is being carried out, the surface pressure causing the film to be transferred from the water to the solid surface. The constant pressure can be most conveniently applied by placing a tiny drop of castor oil or other hydrophilic oil at one end of the water surface ("indicator oil"). When the solid is slowly re-immersed in the solution, another monomolecular layer attaches itself to the surface. The successive layers may have alternating orientation, as is usually the case, or, after from five to ten layers have been laid on, no film forms as the object is raised out of the water, causing deposition only on immersion and resulting in successive layers having only one orientation. By removing the indicator oil, so that the fatty oil or fatty acid may spread freely on the surface, the above process may be reversed so that the solid gives up its soil to the water in a monomolecular layer. This technique has been used to examine tinplate for freedom from the cottonseed oil which is applied in the mill to protect the surface[44].

e. *Optical methods.*—Interference patterns of monochromatic polarized or nonpolarized light as required have been used in analyzing metal surfaces soiled by the Langmuir method to determine the thickness of the film present[12]. With the use of such optical methods on metals soiled by the Langmuir technique, it should be possible to correlate film thickness with plating characteristics.

Reflectometer methods have been used in examing painted metal surfaces to detect the presence of oxide and other films[71]. A highly sensitive rest for the presence of films on surfaces is the use of electron-diffraction patterns. Such a test has been used to detect the presence of oxide films on iron surfaces cleaned cathodically[163] and to analyze hydrocarbon films[91].

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Contribution No. 8 from the Chemical Engineering Laboratories, Engineering Center, Columbia University, New York, N. Y.

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(*Continued from page 157*)

Studies are under way to achieve specific conservation measures.

Cobalt.—No one should imagine that he could substitute cobalt for nickel. According to order M-10, dated December 30, 1950, no cobalt in excess of a total of 25 pounds per month may be purchased except on specific allocation from the NPA, and any person who at any time during any calendar month has in his possession or consumes more than 50 pounds shall report to the NPA.

Copper.—The NPA order M-12, amended on December 30, was not available at the time of this writing, but is said to be very similar to order M-9 of World War II days. The press release of the same date states that it contains a list of articles in which, with few exceptions, no form of copper may be used after March 1, namely, builders' hardware, building material, burial equipment, clothing and dress accessories, furniture and fixtures, hardware, home furnishings and equipment, household appliances, jewelry, gifts and novelties, miscellaneous articles, motor vehicles, and passenger transportation equipment. According to a mimeographed copy circulated prior to the issuance of the order, copper plating of most parts on the list is prohibited. It is also prohibited on all other parts if such plating is for decorative purposes or part of a decoration or unless the normal wear on the article would make impracticable any other form of protective or functional coating.

If the printed copy carries the same prohibitions, a substantial part of present copper plating will disappear.

The prohibitions on copper plating apply equally to copper-base alloys containing 40 per cent or more of copper, i. e., brass and bronze.

Manufacturers are permitted to use, during February, only 85 per cent of the brass mill products (rolled copper and brass anodes) and wire-mill products used during the average month of the first half of 1950, and no more foundry products (cast anodes) than at the quarterly rate of usage during the same base period.

Chemicals.—The only chemical of interest to the plater which causes concern among NPA officials seems to be sulfuric acid. However, because of the sulfuric acid shortage, production of other acids, especially hydrochloric acid, is also suffering. The basic difficulty is shortage of elemental sulfur from which most sulfuric acid is made. Thought is being given to the use of other sources of sulfur dioxide, but no definite plans have been laid for such long-range programs.

No complaints about shortages of cyanides or chromate chemicals had been received.

WASTE DISPOSAL ACTIVITIES IN THE OHIO RIVER BASIN

The second annual report, for 1950, of the Ohio River Valley Sanitation Commission which has just been published gives a very clear picture of the efforts being made in this important area to reduce contamination of the Ohio River and its tributaries.

Considerable space is given to the organization and work of the Industry Action Committees recently organized, including the Metal Finishing Committee, which is under the chairmanship of Walter L. Pinner of the Houdaille-Hershey Corporation. The latter group has organized a number of subcommittees, the work of which will be of interest to platers wherever located. Each subcommittee will prepare a manual on some specific phase of the problem. These include:

Survey-Methods Manual.—Being prepared under the direction of William H. Toller, Jr., Chemical Engineer of Houdaille-Hershey Corporation, this manual will outline in detail the manner in which the volume of waste flows should be determined.

Analysis-Methods Manual.—After flows have been measured, the second step in the definition of a waste problem calls for the determination of concentration of contaminants. This manual will seek to outline the best methods of analyses available within required limits of accuracy. The manual will be based on results of Research Project No. 2 of the American Electroplaters' Society, and will be field-tested by the committee. William J. Neill, President of the A. E. S., is directing this work.

Waste-Treatment Manual.—Here will be presented an evaluation of methods of treatment with respect to cost of operation, ease of control, and degree of treatment. Hubert S. Kline, Industrial-Hygiene Engineer of the General Motors Corporation will direct this study. It is expected that this will point to methods of treatment which will require further study using existing plant installations for experimental work.

Toxicity Limits.—Under the direction of Robert G. Chollar, Research Director of National Cash Register Company, all available information will be assembled on tolerance limits of plating-waste-water contaminants with respect to their effect on humans, fish and sewage-treatment-plant operations. This work will be correlated with a separate project conducted by the Commission with respect to toxicity-tolerance limits.

Basic Waste-Control Measures.—This manual being prepared under the direction Mr. of Pinner will point up the possibilities of reducing wastes from metal-finishing plants through better "housekeeping". Here will be noted proved methods that will also result in reducing operating costs.

Liaison with Steel-Industry Committee.—In accordance with the Commission's plan to coordinate the activities of the industry action committees to prevent duplication of effort, the Metal-Finishing Committee appointed Clyde C. Cupps, Assistant Chief Engineer of Standard Steel Spring Company, as liaison representative to the Steel Committee. That committee in turn has requested Ralph Drews of Republic Steel Corporation to meet with the Metal-Finishing Committee. The liaison program will be integrated so as to provide an overall picture of the past and present research projects and how results might be coordinated.

Another feature of the report is information about the responsible agencies in the States concerned, the laws under which they operate, and the penalties for noncompliance with the laws. This information is summarized in the attached table.

State	Agency	Enabling Act, Effective Date	Penalty for Noncompliance
Illinois	State Water Board	Act of 1929, amended in 1945 and 1949. Eff. July 1, 1929	$100 fine, 30 days imprisonment or both. Each day's continued violation a separate offense
Indiana	Stream Pollution Control Board	Chapter 214, Acts of 1943, amended; Chapter 132, Acts of 1945; Chapter 365, Acts of 1947	$25–100 fine and imprisonment not to exceed 90 days. Also, $100 per day may be recovered in civil suit by the State
Kentucky	Water Pollution Control Commission	House Bill No. 271, 1950. Eff. June 20, 1950	$1000 fine and $1000 for each day violation continues
New York	Water Pollution Control Board	Chapter 666, Laws of 1949. Now Art. 6, Public Health Law	$100–500. Continued violation, $100–500 for each day or imprisonment not to exceed 1 year
Ohio	Dept. of Health	Original authority of 1908 extended and amplified in 1919, 1921, 1935, 1945, 1949	$100–500. Each violation continuing for 30 days a separate offense
Pennsylvania	Sanitary Water Board	Administrative Code of 1923, amended in 1929	$500–5,000, imprisonment for not more than 1 year
Virginia	State Water Control Board	Title 62, Chapter 2, 1950 Code	$50–500. Each day of continued violation a separate offense
West Virginia	State Water Commission	Chapter 16, Art. 11, Code as amended in 1945 and 1947	$25–100, also imprisonment not to exceed 90 days. Each day of violation a separate offense.

ADVERTISING THE PLATING INDUSTRY

As the year 1950 closes and the new year 1951 begins, it seems a suitable time to report to the members of the American Electroplaters' Society what has been accomplished by its Public Relations Committee and what the plans are for the future.

This activity has been made possible by funds earmarked for the purpose from money made at the two Metal Finishing Expositions in Detroit and Atlantic City.

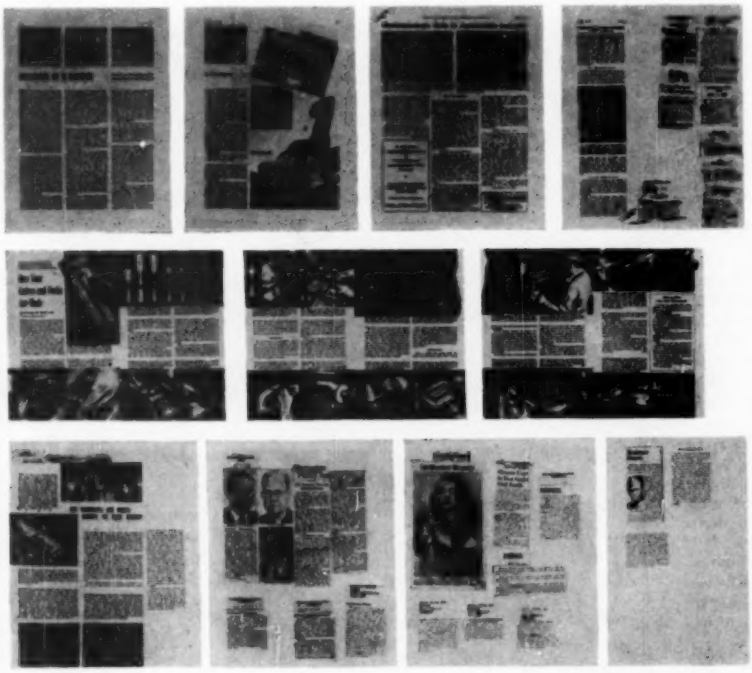
The object of the effort is to promote the sale of plating and its appreciation and demand by the public. The plating industry like any other cannot stand still; it must either grow or go backwards. Most successful industries, for example, the plastics industry, carry on public relations activities and so promote their growth.

The committee realized at an early date that the funds at its disposal were not sufficient to pay for an advertising campaign, and so it did the next best and embarked upon a program confined to editorial material for use in magazines and, to some extent, the daily press. Among the leading articles which have been published, some have had to do with the part plating plays in the silver industry, the automotive industry, the tin can industry, and others. The results obtained for the small amount of money spent are largely attributable to our good fortune of obtaining the part-time services of an experienced author, Wyn Sangster.

Here, briefly, is a picture which should make everybody sit up and take notice. In the relatively short time this program has been under way, twenty-six publications carried our material. These publications reached about five million people. If this space had been paid for at prevailing advertising rates it would have cost $75,000. Actually, less than $7,500 was spent to obtain these results.

The plans for 1951 include the completion of a number of articles which Mr. Sangster has nearly finished. It is our intention to reach more of the popular magazines than we have so far. This, we realize, is going to take some doing, but we believe it can be accomplished.

One of the things we would like to do right now is to get up an article on the potential of the plating industry in a defense or war effort. Your assistance is very definitely required. Will you kindly sit down at your very earliest convenience and write a letter stating what you did during the last World War in the way of plating to help your country? It does not matter how large or small this effort was. It will make good editorial material to help us keep our industry and its capabilities before those who may make use of it. We are in some danger of shutdowns in this transition period, and this is certainly a most necessary effort. We will get this article done as quickly as possible and obtain as wide circulation as we can.



A few of the promotional articles and news stories published by the Public Relations Committee

At the time of the Annual Meeting of the Detroit Branch, a large number of the members of the International Fellowship Club were invited by some of our Society members to discuss the future financing of the Public Relations activities with the object of making public relations more of an industry effort. The idea was taken up immediately, and another meeting was held in the Detroit Athletic Club with the executive group of I. F. C. at which it was proposed to strengthen and extend the program. New members will be appointed from I. F. C. and separate financing will be attempted. The president of I. F. C. has already guaranteed sufficient money to continue this activity up to the time of the convention in Los Angeles.

In closing, will you kindly write me about your previous war activity. Send the letter to Mr. W. M. Phillips, General Motors Research Laboratories, 485 W. Milwaukee Avenue, Detroit 2, Mich.

A. E. S. Los Angeles Convention • June 25-28, 1951

The Educational Program

The Editorial Board of the Society began last spring to plan for the technical sessions. The result is a very practical program, of interest to almost everyone in the industry.

Because few of the visitors are familiar with the strides that were made in California during the last war and subsequent years, the President of the Host Branch, R. J. Wooley, will discuss "Plating on the West Coast" at the opening session.

One regular educational session will center around "Some Engineering Aspects of Plating Room Operations". Papers on heating and temperature control, rinsing, agitation, and diaphragms are expected.

Another session will deal with "Plating Control" and offer papers on physical methods of solution control, evaluation of deposit quality, and practical aspects of current distribution.

Still another session will be an open forum on the "Finishing and Plating of Diecastings".

Finally there will be one session devoted to "General Subjects" and one to "A. E. S. Research".

Details will be given in forthcoming issues of Plating.

The Weather

Our friends in California inform us that the convention-goer will find the State at one of its loveliest seasons. Mild weather with temperatures averaging in the 70's and long sunny days are characteristic of the month of June. Delegates and visitors will be pleasantly impressed with their physical comfort during convention sessions and refreshed in the cool evenings.

Things To See and Do

For leisure time before and after the meetings, the beaches are only a half hour from the Convention Headquarters and the mountains only a couple of hours drive. The season at famed Catalina Island opens in early June, and transportation is available all day to the ferries from downtown Los Angeles and thence to the island.

For other trips in the vicinity, the principal bus terminals are within a five-block radius of the Biltmore (Convention Headquarters), and Union Station is a short taxi ride. Points of interest that can be visited in a day or less include: Laguna Beach, a lovely Riviera-like spot made famous by its artist's colony, Santa Barbara with its well preserved Spanish mission, Newport and its yacht harbor, and Riverside's Mission Inn, a notable museum of early California history.

Closer, within the Los Angeles metropolitan area are the old San Gabriel Mission, the movie lots, the Huntington Library, the Rose Bowl, Forest Lawn, the Wilshire Boulevard Miracle Mile, and a host of others.

Music lovers will enjoy the concerts at the Hollywood Bowl; those with general scientific interests will want to visit the Griffith Park Observatory, and the children will like the zoo in the same park.

All of these features will be accessible to Convention attendants whether they drive, fly or take a train to Los Angeles because of California's excellent highways and public transportation systems.

On the way to or from the Convention, it is easy to visit such places as Sequoia and Yosemite National Parks, Grand Canyon, Hoover Dam, the grandly rugged coastline around Monterey, or the city of San Francisco. For those with little time, a trip by air to Mexico City can be made directly from Los Angeles.

In short, Los Angeles is able to please a variety of tastes in entertainment, good eating, and just plain tourist rubbernecking.

Catalina Island, with its famed marine gardens, casino dancing, golf on the mountain slopes, and fishing for giant tuna and swordfish

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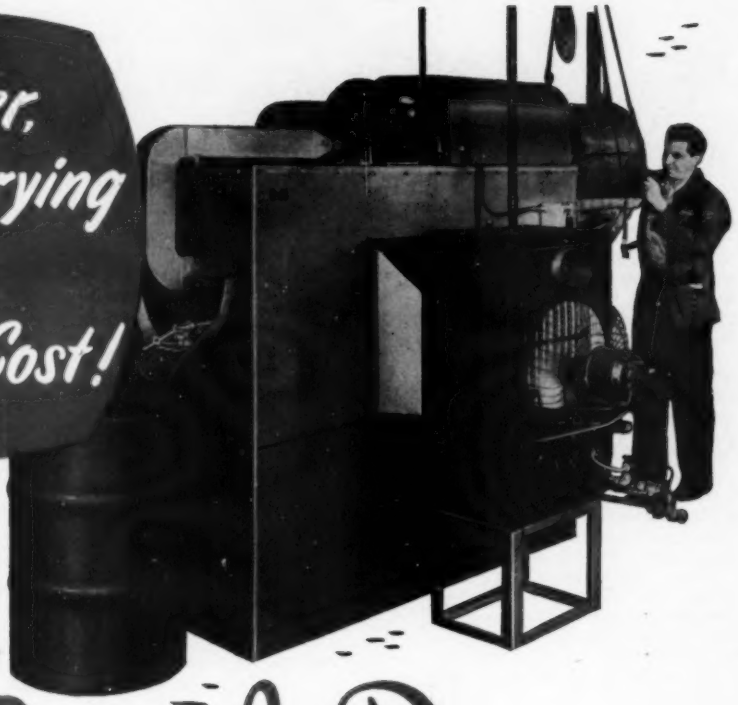

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readers' questions of general interest

Q. 107. The pearl finish on the enclosed metal spinner blade is said to be applied by plating. Please tell us the method that is used.

A. We believe that the finish is produced by the pattern plating process of United Chromium, Inc., silver plating and lacquering. You should contact this company for details.—A. K. GRAHAM.

Q. 108. We have been advised that a Watts nickel plate on steel jigs for chromium plating will not contaminate the solution with nickel and will prevent iron contamination. We have also heard that a chromium plating jig made of lead-alloy-coated copper will be free from the incrustations which eventually prevent current flow from jigs made of pure lead, antimony-lead or tin-lead. What is your experience and opinion?

A. Both iron and nickel will dissolve if anodic and contaminate the solution. If cathodic, they will become coated with chromium and will cause no contamination as long as that condition continues.

A lead-coated copper jig will become covered with lead peroxide if anodic, with chromium if cathodic. In the latter case the lead has the advantage that the chromium can be easily removed from the surface. Lead surfaces become incrusted with lead chromate only when they are allowed to remain in the solution without current for appreciable periods of time. If the fixtures are too heavy to be removed when the current is off, it may be desirable to keep a trickle of current flowing (using a dummy cathode if the fixture is anodic).—A. K. GRAHAM.

Q. 109. I am using steel anodes to get plate into the holes of a part I am cadmium plating, but they do not help. What is wrong?

A. You undoubtedly plate the remainder of the surface by means of regular cadmium anodes. The tank voltage which is sufficient for plating with cadmium anodes probably is not high enough for plating with insoluble anodes in spite of a shorter anode-to-cathode distance. It is therefore necessary to supply separate controls of the voltage between work and regular anodes and between work and insoluble anodes. Usually two separate rheostats are needed, each of required current capacity. If the plating tank has its own current source, however, it may be possible to control the insoluble-anode circuit directly with the generator or rectifier rheostat and have only one separate rheostat for the other circuit. The difference between the total current and the current through the separate rheostat is then the current through the insoluble anodes.—K. G. SODERBERG.

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Book Review

DR. HAROLD J. READ
Associate Professor of Metallurgy, Pennsylvania State College

PROTECTIVE COATINGS FOR METALS by J. W. Gailer and E. J. Vaughan, 1950, xiv + 261 pages. Charles Griffin and Company Limited, 42 Drury Lane, London W. C. 2, England. Price, 24 shillings.

This book is primarily a practical description of nearly all the methods which are presently available for the application of protective coatings to metals, but the detail with which the individual methods are treated varies considerably, e. g., 72 pages are devoted to the electrodeposition of metals, whereas porcelain enamels are dismissed in a half page. Although promises of theoretical as well as technological treatments of the subject matter are made in the introduction and on the dust-jacket, there is actually little or nothing of a strictly theoretical nature. It is true, however, that the suitability of a given coating for particular applications is discussed in terms of the chemical and physical properties of the coating rather than by the cataloging of a few typical uses.

The book is divided into three main parts. The first deals with metallic coatings, which are treated under the headings of electrodeposition, dry processes, and metal spraying. The second section covers nonmetallic and duplex coatings such as phosphate coatings, conversion coatings, paints, lacquers, enamels, and temporary protectives. The final section is devoted to methods of testing and inspection which are widely applicable. Specialized test methods are treated at appropriate places in the text. In addition there are some 26 pages of summary tables in which are presented the essential data for 30 of the processes under the following headings: thickness for a specified environment, physical properties, chemical properties, temperature resistance, general outline of the process, methods of testing, and remarks.

The emphasis placed on individual processes is undoubtedly different than would be the case in a book intended primarily for American readers, but even so the distribution of space seems somewhat unbalanced. It is surprising, for instance, to find that copper plating is covered in less than a third of a page and that no bath formulas are given for this metal, whereas zinc-tin alloy plating is given three pages. No mention is made of silver plating.

The British appear to be very fond of applying trade-names to processes, and a great many of these names are introduced and explained in this book. Such information is very useful in tracking down a process which has been referred to elsewhere by name only.

The usefulness of the book will be based on its wide coverage which makes it of interest for survey purposes.

Article Abstracts

For copies of original articles, turn to your Public Library for photostats or addresses of the publications in question

End Point Indication of the B. N. F. Jet Test for Measurement of Thickness of Cadmium Coatings on Steel. S. G. Clarke and J. F. Andrew. J. Electrodepositors' Tech. Soc. 25, 39 (1950). (Preprint.) Results with the solution previously used have occasionally been unsatisfactory because of lack of contrast between the exposed steel and the cadmium plate. Describes solution which produces a bright mercury spot at a point of the exposed steel while surrounding cadmium is blackened.

From a Metallurgist's Notebook: Corrosion of Chromium. H. H. Symonds. Metal Ind. (London) 76, 167–168 (March, 1950).
Preservatives or brine added to meat passing through a food-processing machine were considered a possible cause of the failure of the chromium plate on aluminum-bronze sleeves incorporated in the machine. Gives details of methods of examination and results. Includes micrographs.

Anodes. Edmond R. Thews. Metalloberflaeche 2, sec. B, 25–28 (February, 1950); 40–43 (March, 1950).
After outlining the most important properties of anodes, the author discusses the factors which indirectly affect their efficiency and life. Shows that the decomposition products deposited on anodes often have a favorable effect on the reaction. Considers anode materials and methods of fabrication. Discusses choice of copper anodes for given electrodes as affected by method of production. Effects of anodic and cathodic polarization are discussed in considerable detail.

The Influence of Surface Behavior on the Characteristics of Electrodeposits. A. T. Steer. J. Electrodepositors' Tech. Soc. Preprint (1950).
Basic theory of the physical state of matter is reviewed, and the problem of examining surfaces and deposits is considered. Wholly crystalline surfaces are said to be in a state of minimum energy content. The more a surface is worked and distorted, as by polishing or buffing, the less crystalline it becomes, and the higher the state of strain and the greater the energy content. The greater the energy content of a surface, the more rapidly it is attacked by chemical reagents. This fact is made use of in etching cross-sections of metallographic specimens in this investigation. Microscopic examinations are made at as high as 3000 ×, and the etching reagent is incorporated in the immersion oil. The progressive etching of the surface is observed and may take from 10 minutes to 2 hours or longer. Speed of etching varies greatly and depends on the energy content of the surface; 24 photomicro-

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graphs are presented. It is concluded that the highest order of adhesion of electrodeposits is obtainable on wholly crystalline surfaces. A plate, such as a bright nickel, at first tends to continue the crystalline structure of the base metal, and this tendency is gradually overcome as the plate becomes thicker, until the typical striated bright-nickel deposit is formed. Apparent voids between plate and base metal are termed "high energy zones".—LYMAN B. SPERRY.

Powder Parts: Machined and Plated. Paul K. Scott. Iron Age. **165,** 87–90 (April 20, 1950).
Describes application of machining and plating to lock production by Illinois Lock Company, Chicago. Gives details of unusual machining operations on part made from brass powder and of chromium plating techniques for powdered-brass locks.

Drag-Out Losses in Wire Plating. Part I. Joseph B. Kushner. Wire and Wire Products **25,** 414–415, 418 (May, 1950).

First of three parts describes determination of drag-out and liquid-film thickness. Dragout is of considerable interest, particularly where precious metals such as gold and silver are being plated.

Soft Grits Provide Low Cost Method for Blast Cleaning Metals. T. F. Clark and E. C. Lathrop. Materials & Methods **31,** 67–69 (May, 1950).
Tells how grits from agricultural residues, such as corncobs, rice, and nut shells, can be used in conventional blasting equipment for degreasing, removing welding scale, and cleaning metal surfaces prior to plating without impairment of dimensions of article.

Electrical Resistance of the Anodic Layer and Optimum Composition of Electroplating Baths. E. Darmois *et al.* Rev. metallurgie **47,** 183–186 (March, 1950).

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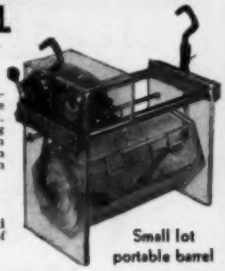

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Corrosion of Steel by Electrolytes Used in Chromium Plating Plants. Lisel Koch. Metalloberflache, 4, sec. A, 65–68 (May, 1950).

Steel is a subject to intercrystalline corrosion, the electrolyte attacking mainly the cementite. Corrosion can be prevented by using low-carbon or carbon-free iron, steel with a decarburized surface, or steel that has been annealed to produce granular pearlite. These conclusions were tested experimentally and confirmed. Includes photomicrographs, a table, and a graph.

The Micro-Estimation of Cadmium. F. P. Dwyer and N. A. Gibson. Analyst 75, 201–203 (April, 1950).
A new reagent, triphenylmethylarsonium iodide, is recommended for nephelometric and gravimetric estimation of cadmium in the presence of zinc. The nephelometric procedure is suitable for 1–100 μg of cadmium per ml with an accuracy of approximately 5 per cent, and the gravimetric procedure for quantities of the order of 10 mg with an accuracy of 1 per cent. However, accuracy of the nephelometric method decreases markedly when the comparative standard and the unknown solution are far apart in concentration.

A New Chromium Long-Life Litho Plate. D. N. Adams. National Lithographer 57, 32–33, 71, 73, 79 (May, 1950).
Reviews some of the pertinent chemical properties of the metals which alone or as alloys make up most polymetallic plates. Describes development of a deep-etch plate utilizing chromium in the nonworking areas and hydrophobic organic coatings in the working areas. Development of an etching solution included evaluation of gold, iridium, palladium, platinum and ruthenium as catalytic agents for release of hydrogen on contact of hydrochloric acid with chromium. For the working surface, best results were obtained with a lacquer formulation of primarily a vinylite resin blended with an acrylic ester resin. This is topped with asphaltum and a developing ink. Test runs up to 250,000 impressions showed no noticeable deterioration.

The Surface Condition of Polished Aluminum, with a Note on the Effect of Surface Scratches. E. A. Owen and Y. H. Liu. J. Inst. Metals 78, 93–104 (September, 1950).
An account is given of X-ray diffraction experiments carried out to investigate the effect of polishing the surface of pure aluminum on different materials, including wash leather, emery paper, aluminum, copper, and zinc. In all cases, the surface of pure aluminum, immediately after polishing, assumes the metastable

state in which the lattice parameter is greater than it is in fully annealed material, so that the crystallites in the polished layer are in a state of strain. The stresses remain in the polished surface at room temperature until removed by suitable heat treatment. The polished layers in the cases investigated were not more than about 0.1 mm thick. The amount of room-temperature recrystallization that occurs after polishing varies with the polishing material, and the effectiveness of these materials changes with the nature of the material. The effect of a single surface scratch on aluminum was also investigated; the recovery curve was found to be similar to the curve obtained with a filed surface. The remote effect of the scratch on the surface of a well-annealed polycrystalline specimen of pure aluminum was found to extend over a distance of at least 1 mm from the scratch.

Protalization—A Simple Chemical Treatment of Light Alloy Surfaces. E. Jaudon. Rev. aluminium **24**, 199 (1947); Chem. Abs. **44**, 7739 (September 10, 1950).

Originally developed for aluminum-copper alloys, this treatment has now been extended to aluminum-magnesium alloys, the degreased alloy being allowed to remain for approximately 10 minutes at 68° F (20° C) in solutions which contain titanium halides. The surface acquires a tint varying from yellow to green according to the alloy. The coating produced, which contains chromium, fluorine, and titanium, affords good protection in the salt-spray test, is a good basis for painting, and does not hinder welding.

The First Commercial Installation for the Continuous Anodizing of Aluminum Wire, Tape and Strip. Anon. Rev. aluminium **27**, 183 (May, 1950); Light Metals Bull. **12**, 655 (August 18, 1950).

A short illustrated note refers to the first commercial installation, in France, apart from an experimental plant, for the continuous anodizing of aluminum wire, tape and strip intended primarily for electrical insulation. Six aluminum wires can be run through the plant simultaneously. The illustration shows an etching bath; two ducts sloping upwards, through which the wires pass and in which they are given a water rinse; the anodizing vat with current capacity up to 1,000 amperes; another pair of inclined rinsing ducts; a drying oven, a varnish impregnating tank, a varnish stoving oven, and finally the stand carrying six reels on which the wires are wound.

An X-Ray Method for Determining Tin Coating Thickness on Steel. H. F. Beeghly. J. Electrochem. Soc. **97**, 152–157 (April, 1950).

The thickness of tin coatings on steel can be measured rapidly and nondestructively on either side of the sheet by application of a simple X-ray technique. The method is based on the selection of an X-ray beam of a wavelength that excites significant amounts of secondary radiation in the base metal but not in the

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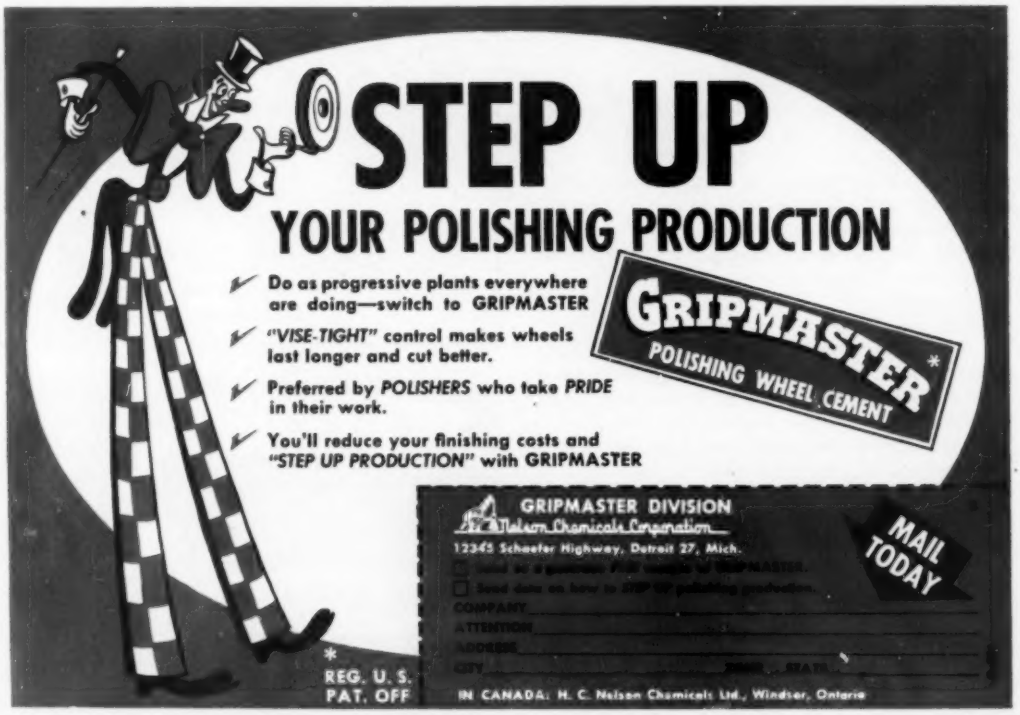
coating. Results are comparable in accuracy and reproducibility to those obtained with the usual chemical methods. The investigation placed emphasis on use of a commercial X-ray spectrometer for measurement of tin-coating thickness on a laboratory scale, but enough work was done to show that the principles used for measuring tin-coating weights on steel is applicable to other coatings and to the continuous indication and control of tin-coating weights on the electrotinning line.

Corrosion of Electrodeposited Nickel. L. C. Flowers and J. B. Kelley. Ind. Eng. Chem. **42**, 719–727 (April, 1950).

An experimental investigation showed that nickel electrodeposits from plating baths containing salts of naphthalene disulfonic acids as brightening agents are dissolved rapidly and continuously at room temperature by distilled water through which carbon dioxide and air are bubbled. Corrosion rates change from 25 to 96 mg/sq dm per day. Electrodeposits from nickel plating baths containing no brightening agent, as exemplified by Watts nickel plate, may be pitted under these conditions but do not corrode rapidly; neither does rolled sheet nickel. The presence of air, or probably oxygen, in the bubbling gas is shown to be of paramount importance. In terms of electrochemical theory, dissolved oxygen acts mainly as cathode depolarizer in the case of bright-nickel plate, and when oxygen is freely available the corrosion reaction is rapid. In the case of sheet nickel or Watts nickel plate, it is believed that a passivity is produced when dissolved oxygen exceeds an undetermined limit; thus the corrosion process is stifled. No explanation can be given for the lack of passivity of bright-nickel plate.

Tumbling for Low-Cost Finishing. A. Bregman. Metal Progress **57**, 625–628 (May, 1950).

Tumbling for polishing and finishing metal products is becoming commonly accepted for large-scale, low-cost finishing. Horizontal tumblers are most widely used because of their larger capacity. Oblique open tumblers are useful for a small or odd-lot production or for self-tumbling. Either wet or dry tumbling may be employed, and each has its advantages for special purposes. Tumbling is not recommended for complete finishing of any and all metal parts, nor is it suitable for complete shaping of parts or for major cutting jobs. In general, it is most economical to tumble parts ranging from 1/16 to 4 inch in diameter; on these, tumble finishing can often show a saving of 50 per cent over buffing. One of the interesting advantages of the tumbling process for diecastings, which are intended for subsequent plating, is that pores and microscopic holes beneath the surface are not exposde as they may be by wheel grinding.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Patent Abstracts

GEORGE B. HOGABOOM
Consultant, New Britain, Conn.

Copies of patents may be obtained by writing to Commissioner of Patents, Washington 25, D.C. Price 25 cents each.

No. 2,530,366, November 21, 1950—Electrophoretic Deposition of Ethylene Polymers—Allen G. Gray, assignor to E. I. duPont de Nemours & Company.

CLAIM 1. In a process for electrophoretically depositing ethylene polymers the step comprising electrolyzing an aqueous dispersion of an ethylene polymer containing a salt of the class consisting of water-soluble ammonium and basic amine salts of a polymeric N-monoalkyl substituted amic acid in which the recurring two non-oxocarbonyl groups are attached directly to adjacent carbon atoms of the polymeric chain, using an electrical conductor as the anode to receive the deposit of ethylene polymer.

CLAIM 2. . . . containing a salt of the class consisting of water-soluble ammonium and basic amine salts of polymeric N-monalkyl substituted styrene-maleamic acid. . . .

3 claims, 3 examples.

References cited: U. S. Patents 2,068,424; 2,079,613; 2,215,145; 2,324,199; 2,345,543; 2,389,414; 2,496,989. Schwartz *et al.*, "Surface Active Agents" (1949), p. 221.

No. 2,530,546, November 21, 1950—Electrophoretic Deposition of Insulating Coating—J. M. Snyder, assignor to Bell Telephone Laboratories.

CLAIM 2. The method of coating a base element by electrophoresis which comprises preparing an electrolyte consisting of inert aluminum oxide particles suspended in a polar solvent mixture, adding a gelatinous activator of aluminm hydroxide to said electrolyte for adsorption on said inert particles thereby ionizing said particles to impart cataphoretic properties to said particles, agitating said electrolyte to maintain suspension of said particles in said mixture, immersing said base element in said electrolyte as a cathode, inserting a metallic anode in said electrolyte, and applying a low current potential of between 15 to 20 volts at a current consumption of 15 milliamperes to said cathode and anode for an interval of 30 seconds, while discontinuing agitation of said electrolyte.

CLAIM 3. A coating suspension for electrophoresis deposition method, consisting of 600 grams of aluminum oxide particles, distilled water and alcohol carrier in the ratio approximately 1 to 2½ and 30 grams of aluminum hydroxide.

4 claims, 3 figures.

References cited: U. S. Patents 1,507,379; 1,640,710;

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1,897,902; 2,215,167; 2,307,018; 2,321,439; 2,386,634; 2,421,652. British Patent 289,509.

No. 2,530,677, November 21, 1950—Apparatus for Plating Crankshafts—E. L. Berkenkotter and J. H. Herz, Chicago, Ill.

CLAIM 1. An apparatus for electroplating the bearing surfaces of a crankshaft having off-set bearings, which comprises means for rotatably supporting such a crankshaft beneath the surface of a plating bath, means for rotating said shaft in said bath whereby said off-set bearings describe a planetary motion, a plurality of anode structures, one for each bearing to be plated, comprising at least one semicircular anode, a depending wall-like insulating spacing element extending substantially the length of the bearing to be plated and adapted to bear against the upper surface of the bearing thereby to hold the anode in proximity to but spaced from said surface, an electrically conducting rod rigidly connected at its lower end to said anode, a plate mounted above said bath having ports therein adapted slidably to receive the upper ends of said conducting rods, flexible electrical leads connected to upper ends of said rods and means for passing an electric current through said leads, through said rods, through said anodes and through plating bath to said bearings serving as cathodes while said bearings and said anode structure describe a planetary motion in said bearing by said spacing elements and being prevented from rotating with said bearings by said rods sliding in said ports.

CLAIM 2. The apparatus of Claim 1 wherein said anode structure includes depending masking elements mounted at either end adapted to confine the current to the space between the anodes and the bearing surfaces.

3 claims, 4 figures.

References cited: U. S. Patents 1,850,426; 1,861,272; 1,880,382; 1,953,955; 2,076,909; 2,323,952; 2,422,242; 2,473,290. British Patents 18,643; 3,087; 154,282. French Patent 877,169.

No. 2,530,967, November 21, 1950—Bright Alloy Plating—G. W. Jernstedt, assignor to Westinghouse Electric Corporation.

CLAIM 1. The method of electrodepositing bright silvery corrosion-resisting coatings of a ternary alloy composed of from 50 to 75% copper, 15 to 30% tin and 5 to 20% zinc upon a member, which comprises making the member the cathode in an aqueous electrolyte comprising essentially 0.5 to 5 oz of free cyanide per gallon, 0.2 to 0.5 oz of copper per gallon, 0.05 to 0.2 oz of tin per gallon, 0.1 to 0.5 oz of zinc per gallon, alkali metal hydroxide, and 2 to 12 oz of alkali metal carbonate per gallon, the electrolyte being maintained at a temperature of between approximately 140 and 160° F and a *p*H of from 12 to 13.5, the anode comprising a ternary alloy composed of 50 to 75% copper, 15 to 35% tin and 5 to 20% zinc and passing

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electrical current through the electrolyte at a potential proportional to the distance between the anode and the cathode, the potential being from 3 to 5 volts between anode and cathode when they are spaced 6 to 8 inches apart, and the voltage being increased or decreased one volt for each 4 inches increase or decrease, respectively, in the spacing between anode and cathode.

2 claims, 1 figure.

References cited: U. S. Patents 2,181,773; 2,198,365; 2,255,057; 2,435,967. British Patent 22,002.

No. 2,531,747, November 28, 1950—Metal Identifier—R. F. Stern.

CLAIM 1. Apparatus for identifying certain of the metals and alloys, comprising an electrolytic device the cathode of which is constituted as a receptacle for the electrolyte and the anode of which is a specimen of the metal or alloy to be identified, in combination with means so calibrated as to directly indicate the identity of the specimen, said means comprising a potentiometer having a movable top, an indicating pointer to which said top is mechanically coupled, said top and pointer being manipulatively adjustable as a unit, a plurality of calibration scales an appropriate one of which is selectable for use when metals or alloys of a predetermined group are to be identified, the selected scale being disposed in underlying relation to said pointer and bearing indicia respecting the metals or alloys of selected group, a bridge circuit one of the arms of which consists of said electrolytic device, another arm in series therewith being of fixed resistance value, and said potentiometer constituting two series-connected arms with respect to which the aforesaid arms of the bridge are parallel-connected, a direct current supply connected across the junctions at the ends of said potentiometer, and a direct current measuring instrument connected between two junction points of said bridge circuit for indicating potential differences between said junction points, one point being the potentiometer top and the other point being the junction between the arms first mentioned, whereby the potentiometer adjustment when made to produce a zero-reading of the measuring instrument will show the metallic identification of the specimen by reference to the position of said pointer along the scale.

2 claims, 2 figures.

References cited: U. S. Patents 1,601,383; 1,845,231; 1,942,046; 2,183,531; 2,319,106. Creighton *et al.*, "Electrochemistry", Vol. 1 (1924), p. 186. Thompson, "Theoretical and Applied Electrochemistry" (1925), p. 31.

U. S. 2,532,516, December 5, 1950—Electroplating Rack—M. S. Schneider.

CLAIM. A rack adapted to be suspended and to support a plurality of articles in an electroplating bath or the like having a transverse bus bar over the same comprising, in combination, a pair of closely adjacent

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metal bars in parallel alignment and electrical engagement with each other, said bars being relatively adjustable longitudinally, one of said bars having a hook at its upper end adapted to hook over the bus bar and thereby to supportingly suspend the rack in the bath and electrically connect it with the bus bar, transverse arms with article-holding free ends secured centrally to said bars in a plurality of groups of three each, a pair of arms of each group being secured to one of said bars and the other arm of each group secured to the other bar, the free ends of said pair of arms forming a support for the lower edge portion of an article to be plated, said free ends each having edge-receiving notch in the upper surface thereof and said free ends being laterally bendable to enable them to be spaced apart as desired to hold the particular article, the free end of the other arm of each group being resilient and located above said pair of ends and adapted resiliently to engage and hold the upper edge portion of the article and press it down against said pair of ends during plating, said upper resilient end having a series of article-engaging depressions on its lower side to accommodate articles in different inclinations to the vertical for rim drainage, said resilient ends enabling the articles to be individually loaded into the respective groups of the rack, a handled lever pivoted to one of said bars and lying alongside thereof when in closed position, and a link pivoted at one end to the other of said bars longitudinally beyond the pivot of the lever, the other end of said link being pivoted to said lever toward the handle end thereof and inside a line joining the pivots of the link and the lever to the bars, said link being longer than the distance from its pivotal attachment on the lever to the pivot of the lever, whereby pivotal movement of said lever from and to its closed position imparts a longitudinal relative shifting of said bars to free the articles from the ends of said arms and to reset ends in article-holding position, said lever and link connections preventing the shifting of the bars in a direction to free the articles when the lever is in closed position.

1 claim, 6 figures.

References cited: U. S. Patents 1,970,458; 2,320,442. French Patent 392,848. German Patents 470,681; 623,718. "Belke Insulated Racks", Bulletin No. 800, Belke Manufacturing Company, March 14, 1939.

No. 2,532,908, December 5, 1950—Electrolytic Processing Apparatus—C. W. Hangosky and C. S. Hornberger, assignors to General Scientific Company.

NOTE. U. S. Patent 2,532,907, the disclosures whereof insofar as consistent herewith, being hereby incorporated and made a part hereof by reference.

CLAIM 6. In an apparatus for electrolytically treating metal surfaces, an apertured plate for supporting a metal object to be treated, means containing a body of electrolyte beneath said plate, a pump for projecting a column of electrolyte from said body onto the

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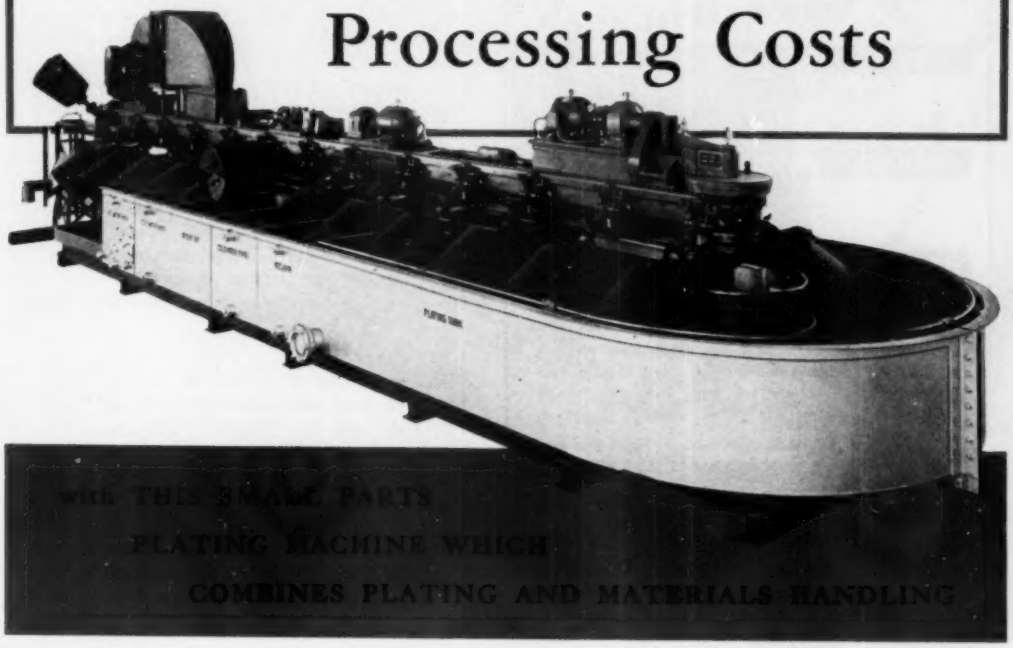

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Patent Abstracts

exposed surface of the object overlying the aperture in said plate, a clamp adjacent said plate for urging the object to be treated against said plate, switch means controlled by said clamp and arranged to energize said pump only when an object is urged by said clamp against said plate, a main circuit including said body of electrolyte, said column and said object arranged to pass an electric current between said column and said object across said exposed face of the object, a relay having contacts included in said circuit for controlling the latter, and auxiliary circuit means actuated by the impingement of electrolyte upon said object for controlling said relay to close said main circuit, whereby energization of said main circuit is dependent upon the column of electrolyte being in contact with said object.

6 claims, 9 figures.

References cited: U. S. Patents 943,188; 1,129,241; 1,285,875; 1,416,929; 1,449,004; 1,809,826; 1,885,702; 1,918,605; 1,940,612; 2,128,331; 2,292,846; 2,319,196. British Patent 335,003. Parcel, "Simplified Electro-Polishing of Steel Specimens", Metal Progress 209–212 (August, 1942).

No. 2,533,464, December 12, 1950—Rack for Supporting Flat Metal Sheets in Electroplating Operations—J. W. Jasper, assignor to Eastman Kodak Company.

CLAIM. A rack for supporting in electroplating operations flat metal work pieces which have a pair of laterally spaced apertures adjacent the upper end thereof, comprising a rectangular rack body having an integral supporting hook on one end thereof, said rack having a pair of parallel vertically extending and horizontally spaced slots positioned adjacent the upper end thereof, a separate clamping-screw member positioned in each of said slots and adapted to be adjusted longitudinally thereof and to pass through the corresponding aperture in the work piece, a pair of upright U-shaped plate members secured to and spaced apart from the opposite end of said rack body on opposite sides thereof by spacers terminating below the upper edges of said plates to provide a horizontal slot on each side of said rack body each of said horizontal slots being adapted to receive the lower end of a work piece, a third clamping-screw member extending through the portion of the rack member located between the respective arms of the U-shaped members and adapted to exert clamping pressure on the rack member and the lower end portion of the work piece resting in the horizontal slot, all of said screw clamping members being adapted to hold cooperatively portions of a flat metal work piece against the plating rack in good electrical contact.

1 claim, 5 figures.

References cited: U. S. Patents 741,274; 1,227,165; 1,354,234; 1,505,608. British Patent 350,658.

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183 FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 149.

A. E. S. News

New Sustaining Members

Four companies have decided to support the A. E. S. Research Program since our last report. The new sustaining members of the Society are:

Aetna Electroplating Company, Philadelphia, Pa.

Brookline Electro Platers, Inc., Chicago, Ill.

The Buckeye Products Company, Cincinnati, Ohio

P. R. Mallory & Company, Inc., Indianapolis, Inc.

Any firm or person interested in promoting the electroplating and metal-finishing industry is welcome to become a sustaining member of the A. E. S. The dues, a minimum of $100.00 per year, are used to pay for the Society's extensive research into important plating and finishing problems, not likely to be studied by private enterprise.

Detailed information may be had from the Executive Secretary or from the Research Finance Chairmen of the Society's branches. Their addresses are found in the Directory in this issue.

The Essence of Knighthood

At the time Walter Pinner was dubbed by the Baltimore Branch he was awarded a richly embellished nickel-chromium plated pot as a badge of his membership in the Order of the Pot. The Milwaukee

Pinner **McGuire**

Branch, having recently learned that Walter had hidden this pot in the Michigan hills to prevent its use as anodic material during the current metal shortage, prepared a substitute for use during the emergency. R. F. McGuire presented the disreputably appearing, olive-drab-painted substitute to Walter at the November dinner meeting of the Milwaukee Branch. At the meeting following the dinner, Walter Pinner delivered his seventeenth annual talk to the Branch, about Nickel Plating, reviewed in the Branch News.

CONTRIBUTION TO RESEARCH FUND

Among the many guests present was

(*Continued on page 194*)

Branch News

Coming Event

DAYTON BRANCH

6TH ANNUAL EDUCATIONAL SESSION AND DINNER-DANCE

Saturday, March 3

Biltmore Hotel

Educational Session at 1:30 P. M.

Speakers: Mr. S. M. Martin, United Chromium, Inc., "Engineering Aspects of Plating Room Layout"

Mr. R. F. Ledford, Hanson-Van Winkle-Munning Company, "Wear Characteristics of Some Common Electrodeposited Metals"

Dr. Charles L. Faust, Battelle Memorial Institute, "Alloy Plating"

Banquet at 6:30 P. M.

Entertainment

Tickets at $6.00 per person from Paul G. Geske, 41 S. Bromfield Road, Dayton 9, Ohio

HERMAN E. AUSTEN

BRIDGEPORT BRANCH

Regular monthly meeting and open educational session was held on November 10 in the Pitney-Bowes Company Auditorium, Stamford, Conn., with fifty-six members and guests present.

TECHNICAL CHAIRMAN RICHARD C. BARRET introduced DR. WALTER R. MEYER, President of Enthone, Inc., New Haven, Conn.

Dr. Meyer, in his talk on "Conversion Coatings on Metals", described methods of producing oxide, phosphate and chromate coatings on such metals as steel, zinc, cadmium, and aluminum. He stressed that these coatings are used both as final finishes and as bases for organic finishes. The talk proved most interesting and provoked considerable discussion.

After a movie, "You Can Change the World", had been shown, refreshments and sandwiches were served, courtesy of Pitney-Bowes Company.

The Sick Committee reported that JOHN J. KEZI was sick. There were two applications for membership, and three new members were elected.

JOSEPH G. STERLING,
Secretary-Treasurer

CHICAGO BRANCH

At the December meeting forty-five members and guests were present to hear MR. E. N. SAMPSON, Engineer of the General Electric Company, talk on the subject of "Rectifiers for Electroplating". Mr. Sampson discussed the manufacture of low-voltage rectifiers and offered suggestions for their operation in order to obtain maximum efficiency. Of particular importance was the discussion on the effect of temperature on rectifier output; in general, it was recommended that the temperature of the air and within the stack column be kept below 100° F.

In addition to his excellent talk, which was followed by an active discussion period, Mr. Sampson also showed a movie of the manufacture of rectifiers.

RAYMOND F. LEDFORD, *Correspondent*

DAYTON BRANCH

No regular meeting was scheduled for December, and instead we had our annual Christmas Party on Saturday night, December 9. The party, which was held at Paradise Gardens in Northridge, again turned out to be a grand affair, and we want to thank RALPH CLINEFELTER, FRANK KLEIN and STEVE PUTZAN for their fine work in arranging it. There were fifty-six persons present, and the evening included dancing, card playing, refreshments, and an exchange of gifts.

Our next social affair will be the Sixth Annual Educational Session and Dinner Dance on March 3 in the Hotel Biltmore. From past experiences you will not want to miss this one. Tickets may be obtained from PAUL E. GESKE, 41 S. Bromfield Road, Dayton 9, Ohio. Telephone WA 8-6351.

R. M. CLINEHENS, *Secretary*

DETROIT BRANCH

The Detroit Branch held its 16th Annual Dinner and Educational Meeting in the Hotel Statler during the afternoon and evening of December 2.

The Technical session, starting at 2 P. M., had an attendance of some three hundred. The feature address by MR. RICHARD E. KRAFKE, Director of Defense Products, Ford Motor Company, about "Sources of Our Strength", was listened to with marked interest and created much favorable comment.

Other speakers included GEORGE W. JERNSTEDT, Manager of Electroplating Projects, Westinghouse Electric Corporation, who discussed "Applications of

CASE HISTORIES

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Former Method: Used an emulsion-solvent type cleaner to preclean parts before final alkaline cleaning prior to plating. Cleaning material cost $180 a month.

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Result of Operation-Change: Using the Magnus Emulso-Clean Process, the cost of cleaning material is cut from $180 to only $55 a month. Not only do they save $125 a month on the cost of cleaner alone, but they get a markedly improved standard of cleaning on all parts. And it takes just about 1/3 of the time to do this better job at lower cost!

On any kind of plating, the advantages of precleaning with Magnusol concentrate (Emulso-Clean) prior to electrocleaning or alkaline cleaning are many, and are exceedingly profitable. We'll be glad to send literature, or much better—to give you a demonstration on your own parts.

For information, write Magnus Chemical Company, 41 South Ave., Garwood, N. J. In Canada—Magnus Chemicals, Ltd., Montreal. Service representatives in all principal U. S. cities.

WES-X Copper and PR Plating" and HARLAND V. OGLE and DR. D. T. EWING, Instructor and Professor of Physical Chemistry, Michigan State College, who dealt with "Distribution of Metallic Impurities in Nickel Deposits". Both talks were listened to attentively. The speakers were introduced by MR. W. J. NEILL, A. E. S. President, chairman of the session.

Highlight of the program was the dinner, floor show and dance that followed the afternoon's business session. The entire ballroom floor of the Statler was given over to the members and guests; when the dinner hour arrived at 7:30 P. M. more than 1,800 members, their wives and guests were seated. This set a new record.

An innovation this year was the arrangement which permitted the show to be run simultaneously in both the main Ball Room and in the Wayne Room, thereby relieving the seating pressure in the former.

Much wearisome work went into the planning of an affair of this magnitude. Credit for the dinner planning belongs to Carl E. Heussner of the Chrysler Corporation and his dinner committee.

Inasmuch as several meetings of the A. E. S. Research Committee were held in Detroit during December 1 and 2, numerous out-of-town A. E. S. members were present at the dinner party. Among them were: DR. W. A. WESLEY, Chairman of the Research Committee; H. H. STRUCKHOFF, Vice-Chairman, Research Finance; DR. WILLIAM BLUM, National Bureau of Standards; J. J. DUFFY, JR., Research Publicity; DR. GEORGE SWIFT, A. E. S. Third Vice-President; M. GLOVER, A. E. S. Law Committee Chairman; and W. J. NEILL, President, and DR. A. KENNETH GRAHAM, Executive Secretary, of the Society.

E. STEEGAR, *Publicity Chairman*

Top, two of the speakers at the Annual Educational Session of the Detroit Branch, G. W. Jernstedt and R. E. Krafke. Bottom, Detroit Branch Secretary J. Gurski, L. C. Borchart, F. L. Clifton and Detroit Branch President Ed Hahn enjoy a lecture by A. E. S. President W. J. Neill. Courtesy O. H. Tiedeman, Wagner Bros., Inc.

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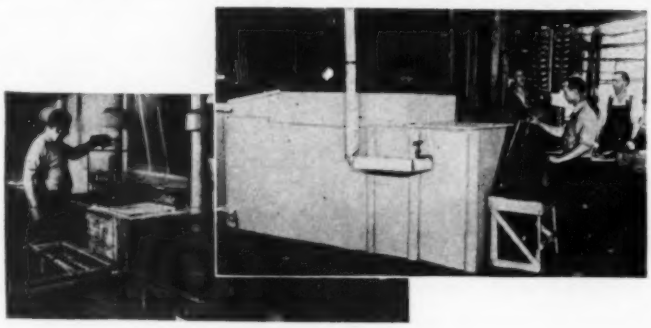

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HARTFORD BRANCH

The educational meeting for December was dispensed with for the Annual Christmas Party and Ladies' Night on December 11.

Approximately eighty people met in the cozy Travelogue Room of the Vagabondia, New Britain, Conn., for cocktails and hors d'oeuvres, and dinner was served at 7:30 P. M. The remainder of the evening was spent dancing and cocktailing. Favors were presented to the ladies, and a good time was had by all.

STANLEY PLATOZ, *Secretary*

JACKSON-LANSING BRANCH

On December 12 thirty-five members and guests sat down in the Hotel Porter, Lansing, to a fine dinner furnished by the Solventol Chemical Company of Detroit.

DR. SCHWARTZ, Solventol's Director of Research, spoke about multiphase cleaners and explained their action in removing various foreign matter. A Westinghouse Electric Company sound movie entitled "Electronics at Work" was shown.

FRED W. STUCKENBERG,
Publicity Chairman

LANCASTER BRANCH

From New York, Philadelphia, Baltimore, Lewisburg, Hanover, Harrisburg, Lancaster, and York they came, 111 strong, to enjoy the Annual Ladies' Night held at the Dutch Club in York, Pa. After a dinner of roast turkey or seafood, the

Rev. Nevin Smith, pastor of the Evangelical and Reformed Church in Hanover, gave a splendid address.

Every lady present received a compact and scarf, and the men received pencils. In addition there were numerous bingo and door prizes. The Branch is indebted to several of its own members and to a number of suppliers for the many gifts and prizes, also to the committee headed by Roland Hoenstine, which so capably took care of all arrangements.

Harry A. Saylor, *Secretary-Treasurer*

MILWAUKEE BRANCH

Hear Ye! Hear Ye! A gentleman of rare accomplishments was knighted at the festive board of the Milwaukee Branch on November 3. At that time McGuire the Mick, lightly touching Walter Pinner upon his worthy brow (with a steak knife) conferred knighthood upon the lad who for 17 years has sought to enlighten us on electrodepositing that rare metal—nickel. Sir Walter was awarded the "Order of the Pot" (Beer City Style) and will retain the trophy for the emergency.

The Branch, in an expansive mood, presented the A. E. S. Research Fund with a check for $200.00. Mr. Clyde Kelly accepted the contribution from President Leslie Diveley.

Glen Schwemer, M.C. for the evening, introduced Judge William I. O'Neill of the Milwaukee County Circuit Court while the worthy members sipped the table wines served from the largesse of Bill Rehberg of the Redi-Products Company. Judge O'Neill eloquently discoursed on the important subject, "The Meaning of Democracy".

Walter Pinner, in his usual engaging manner, then presented a 1¼-hour lecture on all phases of nickel plating. He started with an empty tank and proved the need or explained the value of each material added. Current distribution, anode corrosion, leveling of deposits, brightness, hardness and ductility were dealt with in their proper relation to the whole process. He concluded by mentioning his current subjects of research in nickel plating. The prolonged question period that followed indicated the great interest of the members.

Four new members were elected at this meeting.

E. E. Piellusch, *Secretary-Treasurer*

MILWAUKEE BRANCH

The 414th regular meeting was held at the Red Arrow Club on December 1.

After President Leslie Diveley had appointed Dexter Rhodes, Robert Toeppi and Cy Bivins to the nominating committee, Ted Hartshorn reported progress in the planning of the Annual Educational Session in the Schroeder Hotel on April 28.

Phil Ritzenthaler stated that the Research Committee is actively engaged in obtaining new sustaining members and is planning a plating class for next fall. Five new members were elected.

Gene Bosle introduced Messrs. Walter Cibulskis and E. M. Reiltz of United Chromium, Inc. Mr. Cibulskis discussed "Chromium Plating", covering all phases of bright and hard plating. He also spoke about the merits of the new Self-regulating High-speed bath. He was questioned at length after his talk.

Refreshments were served by the courtesy of United Chromium, Inc.

The plating of aluminum and magnesium will be presented by an outstanding authority at the February meeting.

E. E. Piellusch, *Secretary-Treasurer*

MONTREAL BRANCH

At the regular monthly meeting on December 5, Librarian Paul Jacques introduced as the speaker, Mr. J. A. Lee of General Electric Company. Mr. Lee began his interesting address on "Rectifiers" with a brief history of the research carried out by his company over the past seventeen years. He then dealt with the advantages of rectifiers over generators, the principles of rectification illustrated by blackboard sketches, troubles and correct selection of rectifiers for the job on hand, and difference in efficiency between selenium and copper oxide rectifiers.

During the business meeting that followed one suspended member was reinstated. The Board of Managers was appointed to act as nomination committee.

William Glover, *Secretary*

NEW YORK BRANCH

During the month of November, the

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Whether an acid-proof brick floor stands up year after year without high maintenance costs depends mostly on the joints between the bricks. The thinner the joint the better the chance for long, trouble-free life. But with ordinary bonding mortars you can't get a joint much thinner than ¼".

Durisite *acid-and-alkali-proof* cement, however, bonds brick double-tight with *extra thin* joints . . . $\frac{3}{32}$" or less. Not only does Durisite make a thin, strong joint, but it makes a dense, non-absorbent joint.

Durisite is a resin-type cement, sets quickly by internal chemical reaction, is non-toxic, non-explosive, non-inflammable.

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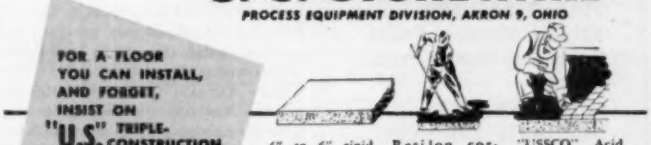

4" to 6" rigid concrete sub-base

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"USSCO" Acid Brick bonded with double-tight Durisite thin joints.

The U. S. Stoneware Co. can supply all necessary materials for installation by your own workmen of a "triple-construction" acid-and-alkali-proof floor, or if you desire, we can handle the entire job, including labor and materials.

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1—10,000/5000 AMPERE, 6/12 VOLT, **HANSON-VAN WINKLE-MUNNING CO.** Separately Excited. Synchronous Motor. Excellent Condition.

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1—5000/2500 AMPERE, 6/12 VOLT, **EAGER ELECTRIC CO.** Separately Excited. Excellent Condition.

1—3000/1500 AMPERE, 12/24 VOLT, **HANSON-VAN WINKLE-MUNNING CO.** Synchronous Motor. Exciter-in-Head. Excellent Condition.

1—2000/1000 AMPERE, 6/12 VOLT, **A. P. MUNNING "OPTIMUS."** Excellent Condition.

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1—1250 AMPERE, 15 VOLT, **COLUMBIA ELECTRIC CO.** Separately Excited. Ball Bearing Design. Practically New.

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INDICATE A 153.

Branch held two scheduled meetings. The first, on November 10, was a closed business meeting. One new application for membership was read, and six new members were balloted into the Society.

Librarian Derick Hartshorn led the group in a discussion on the use of acid in the plating room.

The meeting of November 24 was an open meeting, when the members and their guests heard Mr. G. B. Bowman of Standard Steel Spring Company deliver an excellent talk on "Coronizing, Its Application and Uses".

Grace Aronson, *Recording Secretary*

PHILADELPHIA BRANCH

The regular meeting on December 8, in the Harrison Laboratory, was called to order by President Heiman with approximately forty attending.

Before introducing the speaker, Dr. Heiman introduced two guests from Great Britain, Dr. Hedges and Mr. Lewis of the Tin Research Institute. The speaker was Dr. Frederick A. Lowenheim, Metal and Thermit Corporation, whose topic was "Recent Advances in Tin Plating". He outlined the physical properties of tin and its principal plating applications. He questioned the value of sodium acetate in the sodium stannate bath, as it lacks the buffer action ascribed to it. He described the potassium stannate bath and compared its plating characteristics with those of the slower sodium bath. Information was given on anode behavior.

In addition, Dr. Lowenheim discussed the tin-zinc alloy plating developed by the Tin Research Institute and recently introduced into this country. Tin-zinc alloy gives equal or better protection to steel than cadmium and has the high solderability of cadmium. It has no white corrosion product as does zinc. However, it cannot be plated bright and fingerstains readily, which may be minimized with a supplemental chromate dip. An extended question period followed in which Dr. Hedges and Mr. Lewis joined.

Edwin Ottens followed with a short talk on "Corrosion Resistant Coatings on Steel and Other Metals". He discussed oxide and phosphate coatings, the chemistry of their application, and their performance.

I. Wm. Marcovitch, *Secretary*

ST. JOSEPH VALLEY BRANCH

The regular monthly meeting was held in the Hotel Elkhart, Elkhart, Ind., on December 6. Twenty-six members and guests attended the dinner and thirty-one the technical session.

John Bayman, Chairman of the Research Committee, reported on the sustaining-membership drive. Acting Chairman Richard Lockerbie, First Vice-President and Chairman of the Membership Committee, asked all present to help obtain new members.

Dr. Ernest Wilhelm introduced the guest speaker, Mr. Barney Case, of Hanson-Van Winkle-Munning Company, Detroit, who lectured informally about "Plating Bath Purification". Mr. Case brought out that year by year we learn a little more about the importance of solution purification, but we still lack basic knowledge of the effects of the multitude of impurities which are found in the plating bath. The advantages of good purification were listed as lower costs, less rejects, and better plate quality. Mr. Case illustrated his points with information from A. E. S. research activities, particularly from Projects Nos. 5, 6, 10 and 13. His simple explanations gave the Branch members a better understanding of what the practical plater may eventually expect from these studies that will benefit his own operations.

A lively discussion period followed the outstanding presentation.

Eugene Roth,
Secretary-Treasurer

ST. LOUIS BRANCH

The November meeting was different from the regular run of events, being a joint meeting with the St. Louis Club of Printinghouse Craftmen. This club meets on the same night and in the same hotel that we do. Knowing that its speaker for the evening, Mr. Ray Ledford of the Hanson-Van Winkle-Munning Company and his subject, "The Contribution of Electroplat ng to the Graphic Arts", would be of interest to the A. E. S. members, the Club of Craftsmen had invited us to be their guests. The response was very gratifying.

At the December meeting Dr. F. A. Lowenheim of the Metal & Thermit Corporation gave a very interesting lecture augmented with slides. One application for membership was approved. Refreshments were furnished by Sommers Supply Company of St. Louis.

Ed. Hunleth, *Secretary*

SOUTHEASTERN BRANCH

The regular monthly meeting in the dining hall of the Georgia School of Technology on November 10 had an attendance of fourteen members and guests. It had originally been scheduled for Spartanburg, S. C., but unavoidable circumstances made that impossible. In the absence of President E. J. Slemons, First Vice President D. J. Griffin of Birmingham, Ala., presided.

Very little progress had been had in placing Plating in the libraries of the three cities mentioned in past reports, but better reports were promised at next month's meeting.

The guest speaker, Mr. Charles W. Ostrander of Allied Research Products Company, gave a very enlightening talk on the prevention of corrosion of zinc and aluminum by the use of chromate films.

Wm. T. Weymouth,
Secretary-Treasurer

The ULTIMATE IN BRIGHTENERS!

ROHCO 20XL FOR CADMIUM

ROHCO 20XL gives cadmium deposits without parallel in brilliance of deposit, uniformity of thickness and covering power. Because barrel solutions may be operated at temperatures up to 105° F., maximum production is maintained. Wide latitude of operable concentration range provides exceptional ease of control. In addition to these many desirable plating properties—the low cost of ROHCO 20XL many times is less than the savings in cadmium metal alone.

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SAVES ZINC
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This new, chromate, bright-type finish for automatic zinc plating can be applied to zinc plate *of less than .0001" thickness!* It's bluish bright or yellow iridescent in appearance, according to your needs. Resists corrosion, finger marking, staining.

Costs Less To Use— Cost per square foot of treated surface ranges from as low as 3/100c for mill-plated strip to only 1/10c on piece parts. Your present automatic plating cycles present no problem since the solution is completely flexible and can be adapted to any available immersion period, up to more than a full minute. And we've eliminated the need for a bleaching rinse after Iridite. *One dip does it all!* No close controls or special equipment needed.

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Many manufacturers have already tested and specified this new Iridite finish for all types of zinc-plated products. You will, too, once you've seen and tested it for yourself. *Write today for full information and free samples.* Or, send us a sample of your product for free test processing.

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SPRINGFIELD BRANCH

Thirty-two members and guests attended the meeting on September 25 to hear Mr. Harry Sanders, Enthone, Inc., New Haven, Conn., discuss two subjects: "The Plating Material Supply Situation" and "Boston Convention Papers". Following a review of the supply situation, he advised the platers (1) to reduce solution concentrations to lowest safe operating limits and make more frequent additions to maintain the new standards and (2) to use dragout rinses, especially where the dragout is returned to rapidly evaporating hot solutions.

Special attention was given the Convention papers dealing with high-speed chromium plating, adhesion of deposits, and methods of leveling deposits. Each member should study them in light of his own needs for reducing costs.

P. W. Prouty, *Secretary*

SYRACUSE BRANCH

Mr. H. C. Irvin, President and General Manager of Allied Research Products, Baltimore, Md., spoke at the November meeting about present-day threats to the democratic ideas and of rights to personal dignity, opportunity, initiative, participation in affairs of common concern, providing for the future.

A general discussion followed of new processes brought out by his company, especially treatments for thin zinc deposits and for aluminum (in some cases replacing electrolytic treatments).

Five new members were elected.

Refreshments were served the twenty-six members and guests present through the courtesy of Maas & Waldstein Company and its representative, Frank Czeck.

Lindley S. Wood, *Secretary*

A. E. S. News

(Continued from page 188)

Clyde Kelly from Chicago, a member of the Research Committee. Clyde spoke briefly on the subject of raising funds for the Research projects, after which L.

Kelly **Diveley**

Diveley, President of the Branch, presented him with a check for $200.00 as a contribution from the Milwaukee Branch to the A. E. S. Research Committee.

Membership Report of the A. E. S.

Elections

BALTIMORE-WASHINGTON BRANCH: Charles W. Clark

BRIDGEPORT BRANCH: Almerico Pandolfi, Jesse G. Sneed

CHICAGO BRANCH: G. J. Feiden, E. H. Fell, G. F. Kahle, H. L. Rasmussen, G. Westerberg, Jr., K. Westerberg

CINCINNATI BRANCH: Charles R. Sorber election in error

CLEVELAND BRANCH: R. F. Cahill, Dennis Durbin, M. F. Hodnick, John Nahilo, Jr., R. Radco, J. A. Zehnder

HARTFORD BRANCH: Lloyd H. Curkin, Erling F. Rosholdt

INDIANAPOLIS BRANCH: Robert E. Blake, Russell L. Bowers, Erval D. Hilligos, A. F. Raml, G. R. Van Houten

JACKSON-LANSING BRANCH: Charles H. Bowers, Arthur A. Brouwer, Kenneth R. Haworth, R. L. Nyquist

LOS ANGELES BRANCH: Milton L. Crompton

MILWAUKEE BRANCH: Walter Guenther, Milton Johnson, Stanley E. Mey, William K. Rehberg, Elmer Wentorf

NEWARK BRANCH: Allan S. Grayzel, Arnold Grayzel, Anthony J. Ridolfi, A. O. Squitero, C. Theodos, D. J. Wahler

NEW YORK BRANCH: William M. Bramson, John A. Gilberg

SAGINAW VALLEY BRANCH: Clayton A. Houle

SPRINGFIELD BRANCH: Everett J. Avault, J. Lionel Gagnon

MEMBERSHIP-AT-LARGE: Thomas H. Adams, Decio Griffini, Haridas D. Khimji, A. C. Lavallee, A. W. Waitbank

Reinstatements

CLEVELAND BRANCH: W. J. Cannon, Paul F. Vicari

NEW HAVEN BRANCH: H. B. Smith

SOUTHEASTERN BRANCH: J. W. Wilson

TOLEDO BRANCH: C. C. Mitchell

Transfers

John C. Hampson to Chicago Branch; Charles R. Sorber from St. Louis Branch to Cincinnati Branch; Hans Gernes to Columbus Branch; Fred G. Brune to Columbus Branch; G. M. Kerr to Detroit Branch; William P. Foley to Los Angeles Branch; George Magurean to Los Angeles Branch; Perry Sloane from Montreal Branch

Resignations

CLEVELAND BRANCH: Karl S. Willson

HARTFORD BRANCH: G. Giannattasio, R. K. Hungerford, John C. McCullough, Edward E. Murphy

Suspensions

CHICAGO BRANCH: Benedict W. Wagner, Norman C. Wagner

INDIANAPOLIS BRANCH: C. Hauri

SPRINGFIELD BRANCH: C. E. Butler, W. F. Hanford, F. M. Malison, C. Simpson

Deaths

DETROIT BRANCH: James A. Seeman, C. E. Heussner

MILWAUKEE BRANCH: E. C. Yaeger

Membership Competition

BRANCH	Membership* April 1, 1950	New Members	Net Change in Membership	Per Cent Net Change
FIRST GROUP				
GRAND RAPIDS	141	6	+17½	+12.4
NEW YORK	280	22	+23	+ 8.2
DETROIT†	483	46	+39½	+ 8.2
MILWAUKEE	124	22	+ 9½	+ 7.7
CHICAGO	372	40	+28	+ 7.5
BOSTON	142	15	+ 5	+ 3.5
TORONTO	124	7	+ 3½	+ 2.8
BRIDGEPORT	155	9	+ 4	+ 2.6
WATERBURY	125	8	+ 3	+ 2.4
LOS ANGELES	201	25	+ 2½	+ 1.2
PITTSBURGH	142	2	+ 1½	+ 1.1
PHILADELPHIA	192	19	+ ½	+ 0.3
CLEVELAND	195	28	+ ½	+ 0.3
HARTFORD	132	8	− 1	− 0.8
NEWARK	238	10	− 4½	− 1.9
SECOND GROUP				
MELBOURNE†	111	18	+10	+ 9.0
INDIANAPOLIS	97	14	+ 6½	+ 6.7
MONTREAL	68	9	+ 4½	+ 6.6
CINCINNATI	87	4	+ 3	+ 3.4
NEW HAVEN	106	10	+ 2½	+ 2.4
ST. LOUIS	97	9	+ 2	+ 2.1
BALTIMORE-WASH.	85	8	− ½	− 0.6
BUFFALO	77	1	− 3	− 3.9
DAYTON	97	1	− 4½	− 4.6
SYRACUSE	85	12	− 4	− 4.7
ADELAIDE	72	4	− 6	− 8.3
PROV.-ATTLEBORO	112	3	−12	−10.7
TWIN CITY	71	..	− 8	−11.3
SYDNEY	109	7	−13	−11.9
ROCHESTER	104	8	−16	−15.4
THIRD GROUP				
ROCKFORD	64	9	+ 9	+14.1
ALLENTOWN-READING	37	6	+ 5	+13.5
COLUMBUS	47	3	+ 5½	+11.7
ST. JOSEPH VALLEY	66	8	+ 4	+ 6.1
HAMILTON	23	1	+ 1	+ 4.3
WESTERN ONTARIO	23	..	.....	.....
SPRINGFIELD	51	3	− 1½	− 2.9
JACKSON-LANSING	57	4	− 3½	− 6.1
LANCASTER	62	2	− 4	− 6.4
SOUTHEASTERN†	54	3	− 4	− 7.4
TOLEDO	49	3	− 4	− 8.2
SAGINAW VALLEY	64	5	− 8	−12.5
SAN FRANCISCO	66	10	− 9	−13.6
LOUISVILLE	25	1	− 3½	−14.0
OUTSIDE COMPETITION				
AT LARGE	104	26	+16	.....
IN TRANSFER	27	..	− 7	.....
TOTAL A. E. S.	5,236	462	+86	1.6

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*Subject to correction. †Winners of membership competition in 1949–1950.

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CINCINNATI meets fourth Wednesday of each month at 8 P. M. in Engineering Society Headquarters, McMillan Street and Woodburn Avenue. Secretary, Charles Wise, c/o The Buckeye Products Company, 7020 Vine Street, Cincinnati 16, Ohio.

CLEVELAND meets first Friday of each month in Cleveland Hotel at 8 P. M. Secretary-Treasurer, Harry Pochapsky, 24961 Euclid Avenue, Euclid 17, Ohio. Research Finance Committee Chairman, Howard A. Blouch, 12901 Elmwood Avenue, Cleveland 11, Ohio.

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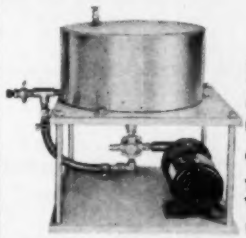

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DAYTON BRANCH, A. E. S. 6th Annual Educational Session and Dinner-Dance in Biltmore Hotel on March 3.

AMERICAN SOCIETY FOR TESTING MATERIALS Spring Meeting and Committee Week in Cincinnati, Ohio on March 5–9.

CONFERENCE ON INDUSTRIAL PERSONNEL at Columbia University, Department of Industrial Engineering, New York City, on March 19–23.

BOSTON BRANCH, A. E. S. Annual Technical Session and Banquet in Hotel Statler, Boston, Mass., on April 7.

FOURTH NATIONAL MATERIALS HANDLING EXPOSITION AND CONFERENCE in International Amphitheatre, Chicago, Ill., on April 30–May 4.

AMERICAN SOCIETY FOR TESTING MATERIALS Annual Meeting in Atlantic City, N. J., on June 18–22.

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5—2000 amp., 6 volt, Jantz & Leist interpole generators connected to 20 HP., 3 phase, 60 cycle, 570 RPM. type KT-332 Gen. Elec. motors.
1—1900 amp., 35 volt, 575 RPM. Star ball bearing generator with AC motor.
1—1000 amp., 40 volt, 600 RPM. Burke ball bearing generator with AC motor.
2—600 amp., 40 volt, 1800 RPM., type SK126L Westgh. generators with AC motors.
1—300 amp., 25 volt, 1750 RPM., type SK-110L Westgh. generator with AC motor.
6—500 amp. Gen. Elec. Rectifiers, 3 phase, 60 cycle, 220 volts to 6 volts D.C.
1—800 amp., 6 volt, Jantz & Leist to a 10 HP., 685 RPM., 3 phase motor.
1—500 amp. Hansen Van Winkle, 6 volts to a 5 HP., 3 phase General Electric Motor.
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